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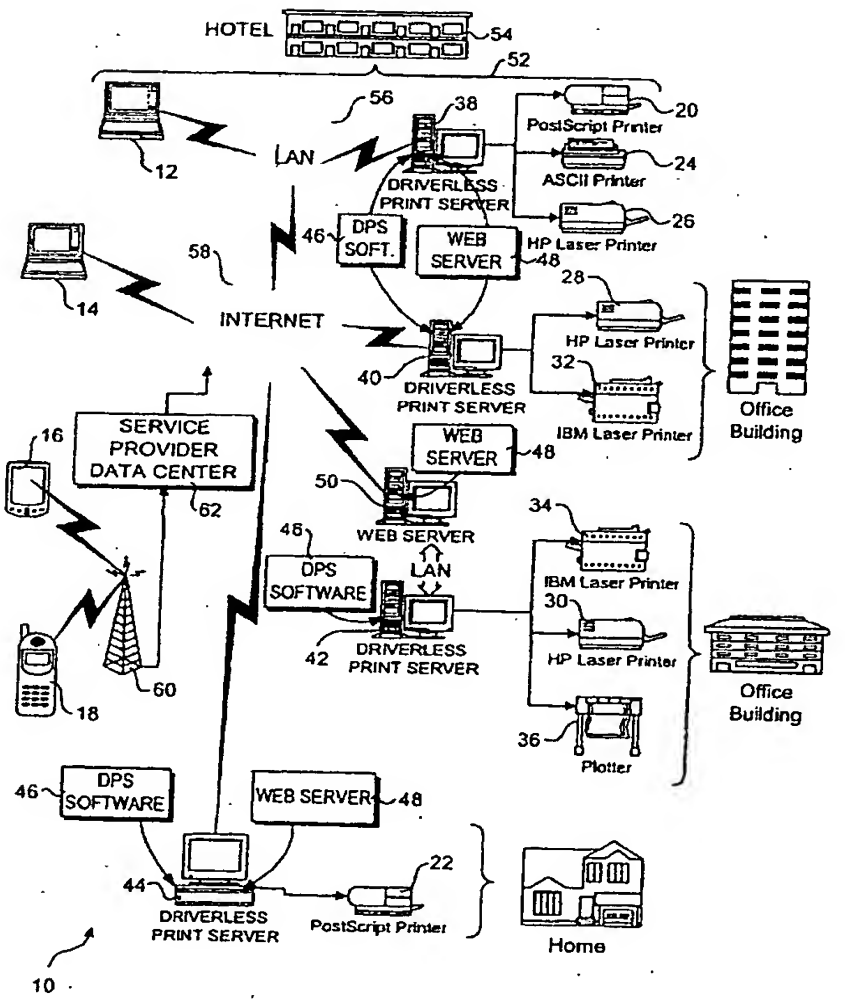

(57) **Abstract:** A system and method that enables users operating originating devices, such as PC's, laptop computers, PDA's, pocket PC's, cell phones, etc., to print documents, images, and web pages via a "driverless" print server (DPS) system without requiring any printing device drivers to be loaded on the originating device. The server system utilizes a table driven mechanism to process and handle various printer events generated by various software applications pertaining to the documents desired to be printed by operators of the originating devices. Print data corresponding to a document is then directed over various networks to a selected target printer. The system provides two-way communication between the DPS server computer and the originating device as well as two-way communication between the DPS server computer and the target printers.

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SYSTEM AND METHOD FOR PRINTING OVER NETWORKS VIA A PRINT SERVER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention concerns computer printing in general, and in particular concerns a system and method that enables various originating devices to print to selected printers over various networks without requiring the originating devices to load any printer device drivers.

2. Background Information

Typically, in order to print out a document, it is necessary for an originating device, such as a personal computer (PC), laptop computer, personal digital assistant (PDA), pocket PC, etc., to have a printer device driver loaded prior to being able to print. The printer device driver provides an abstracted interface between the operating system (OS) and a specific printer to enable the operating system (and applications running on the OS) to communicate with any printer supported by the OS using a common set of text, graphic, and layout commands. This enables developers to develop applications without having to be concerned (generally) with the specific operations of the various printers that may be used with the application. These specific operations are handled by the OS in combination with the printer device drivers.

In today's mobile business environments, business people often encounter situations in which they are away from their home office, yet need to be able to print out documents at either a nearby printer or a selected printer proximate to a business contact they wish to provide one or more documents to. Generally, in order to print to either printer, two things need to happen. First, a mobile computing device on which the document files are stored (or through which they may be accessed) must be linked in communication with the destination printer. This may typically be performed by connecting to a network to by which the printer may be accessed, or by directly connecting to

the printer via a printer cable (e.g., serial, parallel, or USB cable). In many cases, both of these connection solutions may be impractical or unavailable. For instance, many business printers are designed to be connected to a network and administrators do not want their network connection disrupted by connecting the printer to the originating mobile computing device via a printer cable. Furthermore, the network to which the printer is connected may be a private network that the administrator will not allow "foreign" computers to be connected to.

The second half of the foregoing problem pertains to the printer device driver. As discussed above, in order for the mobile computing device to be able to print via a printer, an appropriate printer device driver must be loaded on mobile computing device. In general, a specific device driver will be required for each unique type of printer (even unique models within a similar line of printers). These drivers take time to load, occupy stored space, and may cause software conflicts with other applications on the mobile computing device. Additionally, the business person may not have access to the needed driver. In some instances, a suitable printer driver may be available via the media from which the OS was originally installed, which people generally don't carry with them when away from the office. Oftentimes, the printer will comprise a model that was made available after the OS was released, whereby the only way to load the appropriate driver is to have a specific device driver that was provided with the printer. Short of being able to download the specific driver via the Internet, the business person will simply be out of luck, having no way to print via the destination printer.

SUMMARY OF THE INVENTION

The present invention provides a system and method for allowing communications between various originating devices operating various operating systems across various networks to enable the originating devices to print documents via a "driverless" print server system without requiring any printing device drivers to be loaded on the originating device. The server system utilizes a table driven mechanism to process and handle various printer events generated by various software applications pertaining to the documents

desired to be printed by operators of the originating devices. Output is then directed over various networks to a selected target printer. The server system provides two-way communication between the server and the originating device as well as two-way communication between the server and the target printers.

In a typical implementation, a user operating an originating device, such as a PC, laptop, PDA, pocket PC, cell phone, etc., accesses the Driverless Print Server (DPS) system via a Web browser, such as Internet Explorer, Netscape Navigator for devices operating Microsoft Windows operating systems, or a Web browser specific to the OS used by the originating device. By entering an appropriate URL (uniform resource locator), the user may connect to a web site that supports one or more DPS printers. The user may then select a document or image stored on the originating device or accessible through the originating device (e.g., via a network connection to a storage device on which the document is stored), select a target printer, and request the document be printed via the target printer. Optionally, the user may select a Web URL to print. The print request may further include printing options, such as number of copies, type of paper, n-up colors per page, color or monochrome, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a schematic diagram of exemplary infrastructure in accordance with one embodiment of the invention that enables users of various originating devices to print documents on selected target printers via a "driverless" print server (DPS) system, wherein printer device drivers corresponding to the target printers do not need to be loaded on the originating devices;

FIGURE 2 is a block schematic diagram illustrating various software components that are used to provide the operations provided by the DPS system in accordance with one embodiment of the invention;

FIGURE 3 is a representation of a Web page that is rendered via a browser on an originating device to enable a user to select to print a file;

FIGURE 4 is a representation of a Web page that is rendered via a browser on an originating device to enable a user to select to print a Web page;

FIGURE 5 is a representation of a Web page that is rendered via a browser on an originating device to enable a user to view status information pertaining to a previously submitted print request via the DPS system;

FIGURE 6 is a representation of a Web page that is rendered via a browser on an originating device to enable a user to view the various file types that are supported by a given DPS site;

FIGURE 7 is a block schematic diagram illustrating various CGI scripts that are used by the DPS system to enable interaction with consumer and administrator users;

FIGURE 8 is a block schematic diagram illustrating various software components corresponding to the driverless print server software in accordance with one embodiment of the invention;

FIGURE 9 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to enable the administrator to view print queue information for a given DPS site;

FIGURE 10 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to enable the administrator to view completed print jobs for a selected date range for a given DPS site;

FIGURE 11 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to enable the administrator to view completed print jobs for a selected owner for a given DPS site;

FIGURE 12 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to

enable the administrator to view completed print jobs for a selected printer for a given DPS site;

FIGURE 13 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to enable the administrator to view all completed print jobs for a given DPS site;

FIGURE 14 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to enable the administrator to view various completed print jobs information based on selectable search information input by the administrator;

FIGURE 15 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to enable the administrator to view and edit file type information pertaining to document file types supported by a given DPS site;

FIGURE 16 is a representation of a Web page that is rendered via a browser on a DPS server or via a client device used by an administrator user to enable the administrator to view and file extension and corresponding application information pertaining to document file types supported by a given DPS site;

FIGURE 17 is a schematic diagram illustrating a typical data flow process corresponding to a print request submitted to a driverless print server;

FIGURE 18 is a combination schematic diagram and flow chart illustrating further operations and logic provided by the driverless print server software;

FIGURE 19 is a flowchart and schematic diagram illustrating the operations and logic employed by a Handle Windows component to handle various dialog and message boxes that may be launched during when processing a print job; and

FIGURE 20 is a schematic diagram of an exemplary computer server that may be used to host a driverless print server installation.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

A system and method for that enables users operating originating devices to print documents, images, and Web pages via a "driverless" print

server (DPS) system without requiring any printing device drivers to be loaded on the originating device is described in detail herein. In the following description, numerous specific details are disclosed, to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention can be practiced without one or more of the specific details, or with other methods, components, etc. In other instances, well-known structures or operations are not shown or described in detail to avoid obscuring aspects of various embodiments of the invention.

Reference throughout this specification to one embodiment or an embodiment means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearances of the phrases in one embodiment or in an embodiment in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

Terminology

The following discussion discloses embodiments in accordance with the invention for implementing driverless print services, whereby originating devices may submit documents to be printed on targeted printers over both private and public networks. In accordance with the disclosed embodiments, the following terms are used:

Server: A computer running software that is accessible over a network.

Web Server: A software program running on a computer or server, which communicates with client computers using the HyperText Transmission Protocol (HTTP) to transmit HyperText Markup Language (HTML) files, Common Gateway Interface (CGI) data, and data files between the client and server computers.

Web Browser: A software application for getting and posting resources over the network, and for rendering content.

Universal Resource Locator (URL): A HTTP address string of a resource on a network. This is usually a Web page or document file.

Source Data: The source data in this document refers to any document or media that can be retrieved and output to a device. The supported input data formats include but are not limited to most of the document processor supported types (e.g. PDF, PostScript, Microsoft Word), Web URL link, e-mail, or e-mail attachment.

Job Request: This refers to a request that a user submits to the system to be processed and sent to an Output Device.

Job Status: This refers to the status of a job request that indicates the current progress of the request processing. It is a mechanism to help users understand the status of their job requests and to help the system administrators to administer them.

Printer: A hardware device that takes an electronic stream of data and creates an image on media such as paper (e.g., a hard copy output of a document).

Windows Printer: In the Microsoft Windows Operating systems, a Printer is defined as the named combination of a printer driver, print processor, language monitor, and port monitor.

Spool File: A printer language file that is created by a MS Windows printer driver. The content of this file is sent directly to the printer for printing.

Internet Printing Protocol (IPP): A protocol similar to HTTP for sending spool files to, and getting print job status from, a networked printer.

Line Printer Remote (LPR): A protocol for submitting spool files to a networked printer.

Infrastructure Overview

An overview of a network infrastructure 10 corresponding to an exemplary implementation of the invention is shown in FIGURE 1. Network infrastructure 10 depicts four originating devices, including laptop computers 12 and 14, a PDA 16, and a cell phone 18. It will be understood that an originating device may include any device that may access a computer network via a network browser, including but not limited to PC's, workstations, laptop computers, PDA's, pocket PC's, cell phones, wireless two-way pagers (e.g., Blackberry devices), and Web TV appliances. Each of the originating devices may access any target printed that is supported by a Driverless Print Server site and may be linked in communication with an originating device via a network connection. Such target printers depicted in FIGURE 1 include PostScript printers and 22, an ASCII printer 24, Hewlett-Packard (HP) laser printers 26, 28, and 30, IBM laser printers 32 and 34, and a plotter 36. In general, any type of printer or plotter may be used as a target printer. As such, the printers and plotter in FIGURE 1 are for illustrative purposes only, and are not meant to limit the types of printers that may be implemented in accordance with the invention.

Each target printer will be connected to a Driverless Print Server computer, as depicted by Driverless Print Server computers 38, 40, 42 and 44. A Driverless Print Server computer comprises a set of DPS software modules 46 (also referred to herein a the Driverless Print Server or the Driverless Print Server software) operating on a computing device, such as a PC, workstation, laptop, or computer server. As described in further detail below, the Driverless Print Server software in combination with Web server 48 provides an interface by which an originating device can print to any printer linked in communication with the computing device hosting the DPS software and supported by the software. In general, Web server 48 may run on the same device as the DPS software, as illustrated by Driverless Print Server computers 38, 40, and 44, or may run on a separate machine, such as a Web server computer 50, as will be recognized by those skilled in the art.

As shown by a grouping bracket˚52, laptop computer˚12, Driverless Print Server computer˚38, and printers 20, 24, and 26 are depicted to reside at a common physical location, such as a hotel˚54. In a typical "hospitality" implementation, a printing service provider, such as a hotel, airport, copy center, etc., may provide a local area network (LAN) that allows originating devices to connect to a Driverless Print Server and associated printers provided by the hospitality site, such as LAN˚56. In this instance, Web server˚48 may function as an Intranet site. In other situations, an originating device may connect to a Driverless Print Server computer via Internet˚58. In these instances, Web server˚48 will function as an Internet Web server that supports one or more corresponding Internet Web sites.

As illustrated in FIGURE 1, typical DPS sites also include office and home sites. In instances in which the DSP host computer comprises a mobile computer, the DPS site may be located anywhere there is an appropriate network connection.

In the case or wireless devices such as PDA˚16 and cell phone˚18, the wireless device will typically be connected to the Internet via a cellular network˚60 that will include a service provider data center˚62 that enables wireless access to Web sites via Internet˚58. Depending on the services provided by the cellular carrier used to establish the wireless Internet link, web navigation may be supported through a translation service, or require direct wireless device support. For example, in the United States, WAP (wireless application protocol) -enabled wireless devices typically provide browsers that are designed to receive data via WML and/or HDML (wireless markup languages that are a variation of HTML designed for wireless devices). In Asia, i-mode devices use a variation of HTML called cHTML. Typical translation services may parse the HTML for a given website and produce appropriate WML to enable site navigation, thereby allowing a WAP-enabled device to browse Web sites. In addition, a growing number of Web sites directly support WAP and/or i-mode devices, thereby allowing wireless devices to browse those sites without requiring translation services.

Further details of one embodiment of the software components by which the invention may be implemented are shown in FIGURE 2. The software

components are logically divided into three groups, including a setup component˚100, a document processing component˚102, and an administration component˚104. Each of these components further include a plurality of software applications, scripts, components and/or modules. Setup component 100 includes a Print Setup module˚106 and an Account Wizard module˚108. Document processing component˚102 includes consumer web pages, CGI scripts˚112, a Driverless Print Server module˚46, a Port Monitor˚114, a Status Monitor˚116, an E-mail module˚118, and a Preview module˚120. Administration component˚104 includes a System Monitor˚122, Administration (control panel) Web pages˚124, an Auto Extension module˚126, and an Auto Update module˚128.

In one embodiment, Print Setup module˚106 comprises a Microsoft (MS) Windows application run by a system administrator to change the configuration of a Windows Printer that is used by the system. The application may be used to convert an existing printer, install a new printer, or delete a printer. Conversion of an existing printer comprises taking an existing printer installation and replacing the operations provided by MS Window's port monitor with Port Monitor˚114. The use of Port Monitor˚114 allows the spool file to be manipulated by the DPS system and allows Status Monitor˚116 to send the spool file to a selected target printer.

Print Setup module˚106 may also be used to install a new printer with an appropriate printer device driver. For example, an administrator can set up a postscript printer by installing an Adobe PostScript" driver for use with the DPS system by using the printer's PostScript Printer Description (PPD) file. If the administrator can provide a PDD, the printer setup module will install the PostScript driver and configure it for use by the DPS system. In other cases, the administrator may provide appropriate printer device driver software for the new printer.

Print Setup module˚106 may also be used to delete a printer. In such an event, the Windows port monitor can be restored as the system's port monitor or a DPS server's support for a selected printer can be completely removed.

Account Wizard module˚108 applies security to a set of Administrative Control Panel Web page files so that the administrator's login will determine

which set of Web pages are accessible. In one embodiment, the system implements three administrative levels, including monitor, manager, and administrative levels. In one embodiment, the account wizard creates these three groups as MS Windows user groups. Furthermore, the account wizard creates MS Windows user accounts and places them into one of the administrative user groups. In one embodiment, Account Wizard module˚108 is a MS Windows application.

Consumer Web pages˚110 provide the user interface for consumer users (i.e., operators of the originating devices) via browsers operating on the originating devices. In one embodiment, the consumer web pages comprise standard HTML Web pages that are viewed by a Web browser. In another embodiment, Consumer Web pages˚110 may include WML, HDML, or cHTML pages to support WAP and i-mode —enabled wireless devices such as wireless PDA's and cell phones.

In one embodiment the Consumer Web pages include a print a file page, a print a web page page, a print job status page, a supported file types page, and help/support pages. An exemplary Consumer Web page˚130 corresponding to a print a file page is shown in FIGURE 3. Consumer Web page˚130 includes a plurality of tabs that enable navigation to corresponding web pages, including a print file tab˚132, a print web page tab˚134, a my print status tab˚136, a more information tab˚138, and an exit tab˚140.

As shown in FIGURE 3, Consumer Web page 130 has print file tab˚132 selected. Accordingly, the web page includes input controls that enable a consumer user to print a selected file. These controls include a last name edit box˚142, a printer selection pulldown control˚144, a number of copies edit box˚146, a select a file edit box˚148, a browse button˚150, and a print now button˚152. The consumer user enters his or her last name in last name edit box˚142, selects a printer via pulldown control˚144, and enters the number of copies via number of copies control˚146. The name is used for tracking purposes, and the list of printers presented via the pulldown control will correspond to the printers supported by a given DPS site. The consumer may enter a file name corresponding to the document the consumer desires to print in select a file edit box˚148, or activate browse button˚150, which will bring up a

conventional MS Windows browse dialog that enables the consumer to select the file by browsing directories on the originating device or a storage device to which the originating device is connected to via a network. Once all of the controls contain appropriate information, the consumer may activate print now button˚152 to request the selected or entered document be printed on the selected printer. A success page (not shown) will then be presented on the browser to indicate whether the request was successfully received.

Activation of print web page tab˚134 causes a Consumer Web page˚154 to be rendered, as shown in FIGURE˚4. As before, the consumer enters his or her last name in an edit box˚156, selects a printer via a pulldown control˚158, and enters the number of copies desired in an edit box˚3. The consumer then enters the URL for the web page desired to be printed in an edit box˚162 and activates a print now button˚164 to request the web page be printed on the selected printer. Again, a success page will be presented on the browser to indicate whether the request was successfully received.

The user may review the status of a requested print job via activation of my print status tab˚136, which will render a Consumer Web page˚166 shown in FIGURE 5. Web page 166 displays various print status information, including a print job name˚168, a progress bar˚170, and a printing status˚172. If desired, the consumer may cancel the job by activating a cancel button˚174.

Activation of more information tab˚138 renders a Consumer Web page˚176 shown in FIGURE˚6. Consumer Web page˚176 includes a plurality of addition tabs, including a file type supported tab˚178, a tutorial tab˚180, a frequently asked question (FAQ) tab˚182, and an about tab˚184. In the illustrated Web page, file type supported tab˚178 is activated. Activation of the file type supported tab will cause information pertaining to the file types and corresponding file descriptions to be displayed in a file type description box˚186 and a file type extension box˚188. In general, the list of file types will depend on the particular applications loaded on the DPS server(s) corresponding to the web site. In some instances, special print service applications may be provided for particular applications, whereby the actual application will not need to be loaded on the DPS server. For example, AutoCad files may be printed via third

party print service applications that do not require a copy of the AutoCad application to be present on the DPS server.

Activation of tutorial tab°180 will cause web pages that provide tutorial information to be rendered. Similarly, activation of FAQ's tab°182 will cause a FAQ's page to be rendered that includes various frequently asked questions pertaining to how to use the DPS service and corresponding hyperlinks to the answers to each question.

CGI Scripts 112 provide the Consumer and Administrative Panel Web pages with advanced functionality. Further details of the CGI scripts are shown in FIGURE 7. A cancel print jobs CGI script°190 is used to remove a print job request from a system. From the consumer Web pages, the script can be called for any print job that is on the print job status Web page. From the administrative control panel Web pages, the script can be called for any print job that has been submitted to the system and has yet to have its spool file sent to the printer.

An automatic extension configuration CGI script°192 searches the server computer for installed applications, discovers which document types can be supported by the applications found, and configures the system to allow print job requests of the file types discovered. The results of this CGI script appear on the supported file types web page (e.g., Web page°176 of FIGURE 6). An update system CGI script 194 is used to compare the installed system components against the latest available components, downloads any new components (when applicable), and installs them on the system.

A Print Request CGI script°196 takes a document file, graphical image file, or URL from the consumer Web pages as an input and creates a print job request to the system. A Job Queue CGI script°198 reads the queue of print job requests from the system and returns the list to the script's calling Web page. A Preview CGI script°200 takes a document file, graphical image file, or URL from the consumer Web pages and creates a print job request on the system in a manner similar to the print request CGI script. However, when the Preview CGI script is called, the system converts the document, image, or Web page to a format for viewing in the consumer user's Web browser rather than sending it to the printer for printing. The Preview CGI script can be called a

second time for the document, image or Web page to instruct the system to send the previewed item to the printer.

A Reset CGI script°202 closes the system applications and starts them again. This script is used as a last resort attempt by the system administrator to clear any program errors that may have occurred. A Status CGI script°204 provides the Consumer and Administrative Control Panel Web pages with the progress status of a print job request. An E-mail Trigger script°206 informs the E-mail module°118 that a message has arrived for an account. E-mail module°118 uses this information to retrieve the message and convert it into a print job request.

The components implemented by Driverless Print Server°46 are shown in FIGURE 8. The Driverless Print Server is the main software component for the system. It comprises an application that runs on the DPS server computer that accepts job requests, queues the requests and directs the print process for the document, image or URL from request to final printing. The Driverless Print Server includes a File Types Configuration list°208, a Browser Print component°210, a Supplemental Application Print component°212, a Shell Extension Print component°214, a Print Preview Component°216, a Job Request Server component°218, a Job Processing component°220, a Handle Windows component°224, and a Job Status component 226.

File Types Configuration list°208 is maintained by the Driverless Print Server. The configuration list has, for each file type, the extension, and the method used to print that file type. When the printing method is provided by Supplemental Application Print component°212, the list contains the path to the application used for printing, the menu commands the application uses to print, and the menu commands the application uses to close the application.

The Browser Print component°210 comprises one of three methods the Driverless Print Server uses to print. In one embodiment, this component uses the application programming interface (API) provided by the Microsoft Internet Explorer (IE) Web browser. Using the IE API, the component runs the browser within a window on the Driverless Print Server application. To print a URL, the Driverless Print Server uses the provided navigate programming interface to

load a Web page into the window. Once the page is loaded, the component uses IE's provided printing programming interface to instantiate a print.

Document and image files can be printed using this method if the IE browser instance on the DPS server computer is configured with a browser plug-in for the type of document or image file requested. For example, consider the IE plug-in for Adobe Acrobat". Adobe Acrobat document files have a PDF extension. If the Acrobat plug-in is installed on the server computer, IE's navigate programming interface allows PDF files to be loaded in IE and IE's print programming interface will allow printing of the file.

The Supplemental Application Print component°212 provides another method used by the Driverless Print Server to print. This component uses File Types Configuration list°208 to find the application associated with the file extension, load the file into the application, execute the print menu command for the application, and close the application upon completion of the printing operation. With the combination of the File Types Configuration list and the Supplemental application Print method, the system administrator can add support for additional document or image types by installing the application on the server machine and editing the File Types Configuration list.

The Shell Extension Print component°214 provides a third method used by the Driverless Print Server to print. This component uses the MS Windows Shell Extensions programming interface to print. The MS Windows Shell Extensions interface is an operating system feature that allows a user to print a document type with a command sent to the application that supports the document type. If the application supports the Shell Extension interface, the application will load the document, print it, and close itself. With the combination of the File Types configuration list and the Shell Extension Print method, the system administrator can add support for additional documents or image types by installing the application on the server machine and editing File Types configuration list°208.

The Print Preview component°216 converts the print job requested document, image or URL into a document format file so the consumer users can view an example of the requested document, image or URL. This component works in unison with Preview CGI script°200. One of the

conversions the Driverless Print Server performs pertains to the Adobe Acrobat document format. Through use of the Print Preview component, the Driverless Print Server creates a spool file by the same methods it would use to create a spool file for printing. However, instead of sending the spool file to status monitor˚116 for sending to the printer, it runs the spool file through the Adobe Acrobat Distiller application, which converts the document into the Acrobat PDF format. This conversion requires that the printer driver is an Adobe PostScript driver. The Driverless Print Server keeps the spool file created in the preview process so that if the consumer user wants to print the document, the DPS can simply send the spool file to status monitor˚116, which will then send it to the printer for printing.

The Job Request Server component˚218 takes print job requests from Print Request CGI script˚196 and queues them for processing.

The Job Processing component˚220 manages print job request from insertion into the job queue until the spool file is sent to the printer. This component reads the queued job requests, determines which one of the three printing methods will be used for printing, submits the document, image, or URL to the determined printing method, handles executing the print command, and submits the spool file to the status monitor for printing. During the stages of the printing process, the status is tracked and made available to any Status CGI script˚204 calls that may be made.

The Handle Windows component˚224 is used to provide reliable printing. Many applications display message boxes and/or dialogs during the printing process to inform or gather information from the user who is requesting printing services. In order to support automatic processing of print requests, there needs to be a mechanism to respond to any message box or dialog that might appear in the application used to print the request. This mechanism is provided by Handle Windows component˚224. The Driverless Print Server watches the server during the printing process for messages boxes and dialogs that might appear. When a new message box or dialog appears, the Handle Windows component reads the information, compares it with known messages or known statements, and closes the message box or dialog according to its

programmed logic. Further details of the Handle Windows component are discussed below with reference to FIGURE 19.

The Job Status component˚226 is provided to maintain a memory-mapped file of all of the jobs in each Driverless Print Server queue. At periodic intervals, job status information is written to the memory-mapped file so that the Status CGI script can read the status of job requests.

A Port Monitor comprises a standard component in the MS Windows printing subsystem. The port monitor receives spooled data form the printer driver via the printing subsystem. A traditional port monitor is responsible for taking the spooled data from the printer driver and delivering it to the printer. In the Driverless Print Server system, Port Monitor module˚114 (FIGURE 2) writes the spooled data to a file. Once the entire spool file has been written to a file, Port Monitor module˚114 messages the Driverless Print Server with the name and location of the spooled file.

Status Monitor˚116 comprises an application that runs on the server computer. It performs a plurality of functions, but it is primarily responsible for sending spool files to printers. After the Driverless Print Server is messaged form Port Monitor˚114 with the location of a spool file, the Driverless Print Server messages Status Monitor˚116 with the location of the spool file, the URL of the printer where the spool file should be send, and protocol information for sending the spool file to the printer. Status Monitor˚116 creates a queue for each requested printer URL. Since the printer can only receive one spool file at a time, it serializes the spool file transmittals. Status Monitor˚116 can create and maintain multiple queues simultaneously.

After the spool file has been successfully sent to the printer, Status Monitor˚116 messages the Driverless Print Server that the job is complete. The job history is updated, and the job is removed from the Driverless Print Server queue. Status Monitor˚116 can be configured to send a message to external systems before or after the spool file has been sent to the printer. An example of an external system might be a hotel billing system, which could use the information to apply a charge to a guest's bill.

The E-mail component˚118 creates a virtual e-mail address for a printer. The consumer user sends an e-mail to the printer to have it print the content of

the e-mail. E-mail component˚118 comprises an application that runs on the server computer. In one embodiment, E-mail component˚118 uses Post Office Protocol 3 (POP3) e-mail servers to retrieve e-mail messages and insert them into the Driverless Print Server queue. In essence, the e-mail component comprises a connection between an e-mail account and the DPS server computer. Setting up an account in the e-mail component consists of entering the POP3 server URL, user name, and password of the e-mail account to use for the printer, then entering the Driverless Print Server printer to use for the e-mail account.

E-mail component˚118 has two operational modes: polling and triggered. When the polling mode is used, the POP3 e-mail server is checked periodically for available e-mail messages. When the triggered mode is used, the POP3 e-mail server is checked for available messages when e-mail trigger CGI script˚206 informs the e-mail component that a message is available. When a new e-mail message is available, e-mail component˚118 downloads the e-mail content, including attachments, from the POP3 server. A print job request is created on the system for the text of the e-mail and for each attachment in the e-mail. A notification of submittal is returned in the form of a reply e-mail when the print job request are made and when the entire contents of the e-mail have finished printing.

System Monitor component˚122 comprises an application that monitors all the other system components, watching for failures and listening for specific requests. When print job requests arrive from Print Request CGI script˚196, if the Driverless Print Server application is not running, the Print Request CGI script can request that System Monitor˚122 start the Driverless Print Server, thus allowing the print job request. System Monitor˚122 periodically sends messages to the Driverless Print Server to get the status of the program and any print jobs in its queue. If the System Monitor detects a failure, it will clear the problem.

System Monitor˚122 may also be used to download and install newer system components. It collects the version numbers of all components in the system and sends them to a system's Update Web site. If the Update Web site replies with information about the availability of newer components, it will

retrieve those components and install them on the system. The System Monitor accepts update requests from its menus or from Update System CGI script˚194.

Administrative Web pages˚124 allow remote configuration and monitoring of a system by administrative users. A security feature is used to prevent access of these Web pages by consumer users. An exemplary Administrative Panel Web page˚228 is shown in FIGURE 9. Administrative Panel Web page 228 provides a plurality of top level tabs for navigating to Administrative Web pages corresponding to the tabs, including a print jobs tab˚230, an about tab˚232, a file types tab˚234, a consumer contact tab˚236, a printer management tab˚238, and a configuration tab˚240.

Activation of print jobs tab˚230 causes a lower set of tabs to be rendered, as shown in FIGURE 9. These include a view print queue tab˚242, a list by date tab 244, a list by owner tab˚246, a list by printer tab˚248, an all jobs tab˚250, and an advanced search tab˚252. As shown in FIGURE 9, activation of view print queue tab˚242 enables an administrator to view pending print jobs for a printer that is selected via a pulldown control˚254. The pending print jobs are displayed in a text box˚256, and the number of jobs in the queue are displayed in a text box˚258. Activation of a more info button˚260 enables the administrator to see more information for a selected print job.

Activation of list by date tab 244, list by owner tab˚246, list by printer tab˚248 and all jobs tab˚250 enable the administrator to view a history of print jobs pertaining to the particular tab selected. For example, activation of list by date tab˚244 allows an administrator to view all print jobs for a given Driverless Print Server for a selected date range, as depicted by an Administrative Panel Web page 262 shown in FIGURE 10. The administrator then enters start date and end date values via edit boxes˚264 and 266 and activates a "go" button 268 to request the records for all the print jobs within the date range be retrieved. The number of results per page may be selected via a pulldown control 270, and navigation between records is enabled by a set of navigation controls 272. Each record includes information pertaining to a start time, owner, document name, print status, a finish time, number of pages printed, total charges, owner address, and printer address.

Activation of list by owner tab˚246 enables the administrator to view information on all jobs submitted to a particular owner, a depicted by an Administrative Panel Web page 274 in FIGURE 11. The owner may be the name of a user, the room number from which a user submitted a job, or another indicator of from whom or where the job was submitted. The owner information is entered in an edit box 276. The administrator then activates a "go" button 278 to retrieve records corresponding to the owner. As before, the number of results per page can be select via a corresponding control (not shown), and navigation between records is enabled via a navigation control set 280.

Activation of list by printer tab˚248 enables the administrator to view all of the completed jobs for a selected printer, as depicted by an Administrative Panel Web page˚282 in FIGURE 12. The identity of the printer for which the print job history is desired is selected via a pulldown control˚284, whereupon corresponding records will be retrieved in response to activation of a "go" button˚286. The number of results per page may be selected via a pulldown control˚288, and navigation between records is provided by a navigation control set˚290.

Activation of all jobs tab˚250 enables the administrator to view information pertaining to all jobs printed through a particular Driverless Printer Server, as depicted by an Administrative Panel Web page 292 in FIGURE 13. As before, the number of results per page may be selected via a corresponding control (not shown), and navigation between records is enabled via a set of navigation controls˚294.

Activation of advanced search tab˚252 enables the administrator to view information pertaining to print jobs that are selected based on various input values, as depicted by an Administrative Panel Web page 296 in FIGURE 14. A date range for the search is entered via start and end date edit boxes˚298 and 300. The printer or printer(s) may be selected via a pulldown control˚302. The owner for the printer may be provided in a block˚304. If no owner is specific, the search will be performed for all owners. A site identification may be selected via a pulldown control 306. The results per page may be selected via a pulldown control˚308. A pulldown control˚310 is provided to enable the

administrator to define a column to sort by. A pair of radio buttons˚312 enable the sort order to be defined as either ascending or descending. Once desired values have been entered and selected, the administrator may initiate the search via a "go" button˚314. A previous set of search parameters may be retrieved via activation of a "previous" button˚316, while the values for the various search parameters may be reset to default values via activation of a "reset" button˚318.

Activation of file types tab˚234 enables the administrator to view and/or edit the file types for documents and image files that may be printed by the Driverless Print Server, as depicted by a Web page 320 in FIGURE 15. Navigation of the various file type records is provided via an edit control set˚322 and an edit control set˚324. The number of records per page may be selected via a pull-down control˚326. If it is desired to edit values for a particular file type, the administrator may activate an "edit" button˚328 in the appropriate row, which will enable the values in the value columns to be edited. These columns include an "Extension" column, an "Application" column, and "Enabled" column, a "Method" column, a "ToLaunch" column, a "ToPrint" column, a "ToClose" column, and a "Static" column. The extension for the file type is entered in the "Extension" column. The name of the corresponding application or type of application (e.g., imaging) is entered in the "Application" column. The file path to launch the application is entered in the "ToLaunch" column. Internal commands for printing from and closing an application may be entered in the "ToPrint" column and the "ToClose" column, respectively. File type mapping information corresponding to a given row can be deleted by marking appropriate check boxes in a delete column and activating a delete button˚329.

Activation of configuration tab˚240 enable the administrator to update and configure the operation of a Driverless Print Server installation. As shown in Figure 16, activation of the configuration tab loads a Web page˚330 that provides three additional tabs, including an update tab˚332, an extensions tab˚334, and a job accounting server tab˚335. Activation of extensions tab˚334 launches an Extensions Web page corresponding to Web page˚330.

When a file is submitted for printing, the Driverless Print Server opens an application corresponding to the file's file type. For example, if the file has a

.doc extension an MS Word application will generally be opened. The application then opens the file, and through its built-in print commands, sends the submitted file to a selected printer. The extensions Web page (i.e., Web page 330) displays rows (entries) that list file type information (in an "Extension" column) and the software application corresponding to the file type (in an "Application Name" column). Each of the entries also displays a priority level for the extension (to define an order in which file types with the same extension are evaluated to determine the appropriate application for the submitted file), a Registry Location that identifies where in the OS registry information pertaining to the application is stored, a Default Path for the application, an Executable Name for the application, and internal codes to print and close the application. An administrator can add a new file type via activation of an "add new entry" button 336, which will render a Web page with corresponding edit controls for each of the columns in Web page 330 (not shown). A similar Web page is rendered in response to activation of an "update file types" button˚338, only in this instance the edit controls will be filled in with values pertaining to a selected file type to be updated. Updating of a file type can also be initiated by activation of an "edit" button˚340. As before, navigating between records is enabled by a set of navigation controls˚342.

The Driverless Print Server uses an Extensions Table corresponding to the file type values to determine which applications installed on the server computer to use for printing files of each file type listed in the Extensions Table. The information in the table is also used to determine the location of the executable files on the server computer. In one embodiment, the Extensions Table and various other configuration and print job data is maintained in a database. Typically, the database will be hosted on the same machine as hosts the DPS software, although a separate machine may also be used to host the database, as will be recognized by those skilled in the art.

Processing a Print Request

A data flow diagram that illustrates data flows and operations performed by the DPS system software components in response to a print request is shown in FIGURE 17. Initially, the user of an originating device 350 will enter the URL for a driverless print server Web site (or Intranet site, if applicable) in

the browser of the originating device to load the consumer user print Web page (e.g., Consumer Web page 130 of FIGURE 3). The user will then enter appropriate information for printing either a document, image, or Web page as discussed above. The entered information will be enabled by ASP controls or a similar mechanism (e.g., javascript, Vbscript, etc.) contained in the Consumer Web pages that are served by the Web server component of the system, depicted as Web server˚353. The user-entered data is depicted as user input˚352, which is received via Web server˚353 and is initially processed by Print Request CGI script˚196, which generates a tmpdoc.dpsn document 354 containing print parameters and other data corresponding to the request. The Tmpdoc.dpsn document is then sent via the Print Request CGI script to a job queue˚356. In one embodiment, the job queue comprises a first-in first-out (FIFO) type of job queue. Optionally, other types of job queues may also be used, as will be recognized by those skilled in the art. As discussed above, job queue operations are performed by job processing component˚220.

The job queue submits job requests to be processed by the system. Each request is processed by a block˚358 in which the tmpdoc.dpsn file is parsed to retrieve print job parameters corresponding to the print request, which are stored in a document file˚360. For example, parsed information may include a printer selection, number of copies, identity of consumer user, document name, etc. A portion of the print job parameters are then stored in a DPS database˚386.

In a decision block˚362, a determination is made to what type of document was requested to be printed, e.g., an application file, an image, or a Web page URL. If the document pertains to a browsable document, such as a Web page, image or a PDF file, the logic flows to a block˚364, wherein the Web page, image or PDF document is loaded via the Driverless Print Server's browser. Otherwise, the logic flows to a block˚366 in which the document and an appropriate supplemental application that can be used to print the document is loaded. For example, if the document comprises a MS Excel spreadsheet, an instance of the MS Excel application is loaded, along with the Excel document. In a block 368, an internal command is generated to simulate a user requesting a print operation to request that the URL, image or document

be printed by either the browser or supplemental application. For example, most applications provide a File->Print menu option that initiates a printing process for the application.

In response to an internal application or browser print request, various printing and document information is passed internally to operating system components that handle printer operations. As discussed above, in one embodiment the Driverless Print Server is operated in an MS Windows OS environment. Accordingly, this environment provides an OS print subsystem 369 including a Graphical Device Interface (GDI) component°370 that interacts with a printer device driver°372 corresponding to the selected printer to generate appropriate printer (i.e., output device) data that will be sent to a target printer°374 to produce an output document. The printer data is internally handled by an MS Windows print spooler component°376 that outputs a print spool file that is received by Port Monitor°114. In the illustrated example, it is assumed that target printer°374 comprises a PostScript printer. Accordingly, Port Monitor°114 outputs a PostScript file°378.

While the foregoing operations are going on, the user of originating device°350 may select to preview a simulated printed output of the document, image or Web page prior to having the source document printed. In a decision block°380, a determination is made to whether the user requested to preview the printer output. If the answer is YES (TRUE), in one embodiment an instance of Adobe Acrobat Distiller°382 is launched, which is used to generate an Adobe portable document format (PDF) document°384. The PDF document is then handled by Preview CGI script°200, which sends the document back to originating device°350 via Web server°353, where it is rendered on the browser running on the originating device via an Adobe PDF plug-in. The rendered display (not shown) will provide a preview of what the printed document will look like and include user interface (UI) controls that will enable the consumer user to select to have the document printed or canceled.

If the consumer user desires to have the document printed, a print notification is sent back to Web server°353, where it is processed by Preview CGI script°200. In response to receiving the print notification, Preview CGI script°200 starts Status Monitor°116 and submits the print document°378 to

target printer˚374. In conjunction with this event, job history information is updated in a DPS database˚386.

In the event that the print preview option is not selected by the consumer user, the answer to decision block˚380 is NO (FALSE), which results in starting up Status Monitor˚116 and submitting print document˚374 to target printer˚374. During the print process, Status Monitor˚116 monitors the progress of the process and updates DPS database˚386. Status CGI-script˚204 is used to provide Web page print status information by retrieving the progress information from the database and generating appropriate HTML to cause the progress information to be displayed in the Web page, such as shown in Web page 166 of FIGURE˚5.

In one embodiment, the Driverless Print Server supports direct printing of printer files. For instance, if the print job file comprises a printer file, it can be directly printed if it corresponds to a printer file type of the target printer. For example, PostScript files may be printed on PostScript printers. Similarly, printer files for other types of printers may have been previously created by selecting a "save to file" option during a print process. If the file is determined to be a printer file in decision block˚362, the logic proceeds to a block˚367, wherein the printer file (depicted by a printer file˚369) is directly sent to Windows print spooler˚376.

Further details of the internal operations of Driverless Print Server software˚46 are shown in FIGURE 18. As before, a consumer user operating originating device˚350 requests to print a document or image file, or a Web page via Consumer Web pages 130 and 154, respectively. In response to activation of the "print now" button on appropriate Consumer Web page, user input data is processed by Print Request CGI script˚196, which creates tmpdoc.dpsn document˚354. The Print Request CGI script also pipes a message containing a print request to a New Job Pipe Server˚390, which stores the messages in a message queue˚392. For each print request message, a Message Queue Handler˚394 starts a corresponding thread that parses the corresponding tmpdox.dpsn document˚354, thereby generating document file˚360 and submitting a print job to job queue 356.

As depicted by a start job queue loop block˚396 and end job queue loop block˚397, the following operations and logic displayed between these loop ends is performed for a print job. First, in a block˚398, the next job is retrieved from job queue˚356. In a decision block˚400, a decision is made to what type of document the print job corresponds to. If the document is an application file, the logic proceeds to a decision block 402 in which a determination is made to what type of file type printing method should be used. If the file requires a supplemental application (e.g., MS Word, MS Excel, AutoCad, etc.), the logic proceeds to block˚366 where the document and appropriate supplemental application is loaded in the manner discussed above. Once the file is loaded in the supplemental application, a file printing command is internally generated in block˚368 to submit the file for printing by the OS, as before.

Next, in a decision block˚404 a determination is made to whether a "Completed" message is received from Port Monitor˚114. This determination is made on a periodic basis or through a software interrupt mechanism until the "Completed" message has been received. Status Monitor˚116 is then started in a block 406, which sends print document˚378 to target printer˚374 and updates the job history data in DPS database˚386, as before.

Returning to decision blocks 400 and 402, if the document type is a Web page or a file type that can be printed directly by the Driverless Print Server computer without requiring a supplemental application (e.g., a PDF document or various types of image files), the logic proceeds to block˚364, wherein the DPS computer's browser is navigated to the URL for the Web page or the browser is otherwise used to render the PDF file or image file. Once rendered, the remaining print operations are performed in the manner discussed above, beginning with block˚368. As discussed above, if the document type is a printer file, the document is directly sent to Windows Print Spooler 376.

A flowchart detailing the logic and operations provided by Handle Windows component˚224 is shown in FIGURE 19. As shown by start blocks˚450 in FIGURE˚17, a Handle Windows thread is launched at the start of decision block˚362 and immediately after the print action has been invoked in block˚368. As discussed above, the Handle Windows component is used to handle various dialog and messaged boxes that may be launched when an

application is loaded, when a document is loaded into an application, when a print action is initiated, during the printing process, etc.

Returning to the flowchart of FIGURE 19, upon being launched, the Handle Window thread makes a determination to whether there are any more desktop windows to examine in a block˚452. Such windows will generally include dialog boxes and message boxes. If there are no more windows to examine, the thread is ended, as depicted by and end thread end block˚454. If there are more windows to examine, the logic proceeds to a block˚456 in which window information for a window is obtained. Under MS Windows operating systems, window information may be obtained by making an appropriate Windows API call.

Next, in a decision block˚458 a determination is made to whether the window is a child window of a rendering application (i.e., was it produced by a supplemental application or a browser). If the decision is no, the window does not correspond to the rendering application, and the logic proceeds to decision block˚452 to evaluate the next window. If the answer to decision block˚458 is Yes (TRUE), the logic proceeds to a block˚460 in which text and control buttons for the window are examined.

As determined by a decision block˚462, if the text matches a standard message string the logic proceeds to a block˚464 in which a window close command is internally provided to emulate a user activating either a close button on the window or the window close icon in the window's frame. The logic then returns to decision block˚452 to process the next window.

If the text does not match a standard message string, the answer to decision block˚462 is No (FALSE), and the logic proceeds to a decision block˚466 in which a determination is made to whether the text matches a corresponding an entry list MessageText value stored in a Handle Windows Table˚470 in DPS database˚386. If there is a matching value, the logic proceeds to a block˚468 in which the table command is executed by retrieving the data in the row of the matching MessageText value and issuing a corresponding message to the Windows API based on the parameters provided by the data. For example, a typical entry list row˚472 is shown at the top of FIGURE˚472. The row contains information pertinent to the Windows

API, including a MessageID, Wparam, and Lparam value. These parameters are used to make a corresponding API call to effectuate the desired operation for handling the window. Once the table command is executed, or if the answer to decision block˚466 is No (FALSE), the logic returns to decision block˚452 to begin processing the next window.

In the foregoing description and accompanying drawings, embodiments of the invention that implement software operations provided by MS Windows operating system components were disclosed. This is not meant to be limiting, as the principles and teaching of the invention may be applied to implementation in which other operating systems are used, such as UNIX-based operating systems and LINUX-based operating systems. For example, various UNIX and LINUX operating systems provide graphical user interfaces, application API's and printing capabilities that are supported by OS kernel components that provide similar operations to the MS Windows printing support components discussed above (e.g., Windows GDI, print spooler, printer drivers, etc.)

EXEMPLARY FILE SERVER COMPUTER SYSTEM

With reference to FIGURE˚20, a generally conventional computer server˚500 is illustrated, which is suitable for use in connection with practicing the present invention, and may be used for the DPS server computer and Web server computer where a separate computer is used for performing Web server operatins. . Examples of computer systems that may be suitable for these purposes include computer servers operating Microsoft Windows, UNIX-based, and LINUX-based operating systems.

Computer server˚500 includes a chassis˚502 in which is mounted a motherboard (not shown) populated with appropriate integrated circuits, including one or more processors˚504 and memory (e.g., DIMMs or SIMMs) 506, as is generally well known to those of ordinary skill in the art. A monitor˚508 is included for displaying graphics and text generated by software programs and program modules that are run by the computer server. A mouse˚510 (or other pointing device) may be connected to a serial port (or to a bus port or USB port) on the rear of chassis˚502, and signals from mouse˚510 are conveyed to the motherboard to control a cursor on the display and to

select text, menu options, and graphic components displayed on monitor˚508 by software programs and modules executing on the computer. In addition, a keyboard˚512 is coupled to the motherboard for user entry of text and commands that affect the running of software programs executing on the computer. Computer server˚500 also includes a network interface card (NIC)˚514, or equivalent circuitry built into the motherboard to enable the server to send and receive data via a network˚516.

File system storage corresponding to the invention may be implemented via a plurality of hard disks˚518 that are stored internally within chassis˚502, and/or via a plurality of hard disks that are stored in an external disk array˚520 that may be accessed via a SCSI card 522 or equivalent SCSI circuitry built into the motherboard. Optionally, disk array˚520 may be accessed using a Fibre Channel link using an appropriate Fibre Channel interface card (not shown) or built-in circuitry.

Computer server˚500 generally may include a compact disk-read only memory (CD-ROM) drive˚524 into which a CD-ROM disk may be inserted so that executable files and data on the disk can be read for transfer into memory˚506 and/or into storage on hard disk˚518. Similarly, a floppy drive˚526 may be provided for such purposes. Other mass memory storage devices such as an optical recorded medium or DVD drive may also be included. The machine instructions comprising the software programs, components, and modules that causes processor(s)˚204 to implement the operations of the present invention that have been discussed above will typically be distributed on floppy disks˚528 or CD-ROMs˚530 (or other memory media) and stored on one or more hard disks˚518 until loaded into memory˚506 for execution by processor(s)˚504. Optionally, the machine instructions may be loaded via network˚516 as a carrier wave file.

Although the present invention has been described in connection with a preferred form of practicing it and modifications thereto, those of ordinary skill in the art will understand that many other modifications can be made to the invention within the scope of the claims that follow. Accordingly, it is not intended that the scope of the invention in any way be limited by the above

description, but instead be determined entirely by reference to the claims that follow.

CLAIMS

What is claimed is:

1. A method to enable a user of an originating device to print source data on a target printer, comprising:

providing data to the originating device from which a user interface can be rendered to enable the user to select the source data to print and identify the target printer;

receiving the source data or indicia identifying the source data from the originating device and providing the source data or indicia to a print server;

loading the source data into a corresponding application or browser running on the print server;

generating printer data corresponding to the source data via the corresponding application or browser and a print subsystem of an operating system running on the print server; and

submitting the printer data from the print server to the target printer.

2. The method of claim 1, wherein the originating device comprises one of a personal computer (PC), laptop computer, workstation, computer server, personal digital assistant device, pocket PC, cellular phone, or Internet appliance.

3. The method of claim 1, wherein the originating device does not require a printer device driver corresponding to the target printer to be loaded on it.

4. The method of claim 1, wherein the source data corresponds to an application file, and the originating device does not require an application corresponding to the application file to be loaded on it.

5. The method of claim 1, wherein the data provided to generate the user interface comprises a set of Web pages served by a Web server that is operatively linked in communication with the print server.

6. The method of claim 1, wherein the source data comprises an application file.

7. The method of claim 1, wherein the source data comprises an image file.

8. The method of claim 7, wherein the image file is rendered on a browser running on the print server and a print action is invoked to cause the browser to submit graphical data pertaining to the image to the print subsystem.

9. The method of claim 1, wherein the source data comprises a Web page.

10. The method of claim 9, wherein the indicia identifying the source data comprises a URL (uniform resource locator) address corresponding to the Web page, and the URL address is used by the browser to navigate to the Web page.

11. The method of claim 1, further comprising providing print status information in the user interface to enable the user to monitor a source data print request submitted by the user.

12. The method of claim 1, further comprising:

defining file type-to-application mapping information that maps each of a plurality of source data file types to one or more corresponding applications that may be used to print source data having that file type; and

in response to receiving the source data at the print server,

determining a file type of the source data;

determining an appropriate application to load on the print server to print the source data;

initiating a print action to cause the application in combination with the print subsystem to generate the printer data; and

routing the print data to the target printer to be printed.

13. The method of claim 12, further comprising providing a user interface to enable an administrator to define the file type-to-application mapping information and define application loading information to enable the applications to be loaded on the print server.

14. The method of claim 13, wherein the user interface comprises a web page served from a web server operatively coupled to the print server.

15. The method of claim 12, wherein an application may display message boxes and/or dialogs during an application printing process to inform a user of an error or warning or gather print parameter information from a user, further comprising automatically providing computer-generated input to handle any message boxes and/or dialogs launched by the application to generate the printer data.

16. The method of claim 1, further comprising providing print preview data to the originating device that comprising a simulated representation of an output of the target printer when rendered on the originating device.

17. The method of claim 1, further comprising providing a Web-based user interface that enables an administrator to view information pertaining to pending print jobs.

18. The method of claim 1, further comprising providing a Web-based user interface that enables an administrator to view information pertaining to completed print jobs.

19. The method of claim 18, wherein the Web-based user interface enables the administrator to view completed print request using a filter based on at least one of a date range, a specified owner, an account, and a specified printer.

20. The method of claim 18, wherein the Web-based user interface enables the administrator to view completed print requests using a filter that is generated in response to a plurality of search criteria entered by the administrator view the Web-based user interface.

21. The method of claim 1, wherein the source data comprises a file that the user is enabled to select via a file browse operation, said file comprising a file that

is either stored on the originating device or stored on a device that may be accessed by the originating device via a network.

22. The method of claim 1, wherein the operations of loading the source data and generating the printer data are performed using an operating system shell extension print mechanism.

23. A machine readable media on which a plurality of machine instructions are stored that when executed by a computing machine enable a user of an originating device to print a hard copy output on a target printer pertaining to source data selected by the user by performing the operations of:

serving Web-based data from a Web server to the originating device to enable a user interface to be rendered on the originating device, said user interfaced having interactive controls to enable the user to select the source data to print and identify the target printer from a list of printers that may be selected to print the hard copy output;

receiving the source data or indicia identifying the source data from the originating device at the Web server;

passing the source data or indicia identifying the source data to a print server;

loading the source data into a corresponding application or browser running on the print server;

initiating a print action to cause printer data corresponding to the source data to be generated by the corresponding application or browser and a print subsystem of an operating system running on the print server; and

submitting the printer data from the print server to the target printer.

24. The machine-readable media of claim 23, wherein the originating device comprises one of a personal computer (PC), laptop computer, workstation, computer server, personal digital assistant device, pocket PC, cellular phone, or Internet appliance.

25. The machine-readable media of claim 23, wherein the source data comprises an application file.

26. The machine-readable media of claim 25, wherein the source data comprises an application file that the user is enabled to select via a file browse operation initiated by a corresponding control in the rendered user interface, said application file comprising a file that is either stored on the originating device or stored on a device that may be accessed by the originating device via a network.

27. The machine-readable media of claim 23, wherein the source data comprises an image file that is rendered on a browser running on the print server and a print action is executed by the browser to submit graphical data pertaining to the image to the operating system print subsystem.

28. The machine-readable media of claim 23, wherein the indicia identifying the source data comprises a URL (uniform resource locator) address corresponding to a Web page, and execution of the machine instructions further performs the operations of:

loading a Web browser;

passing the URL address to the Web browser so that the Web browser can navigate to the Web page;

activating a print operation provided by the Web browser to cause printer data corresponding to the Web page to be generated by the browser in combination with the print subsystem.

29. The machine-readable media of claim 23, wherein execution of the machine instructions further performs the operation of serving an interactive Web page providing print status information to enable the user to monitor a source data print request submitted by the user.

30. The machine-readable media of claim 23, wherein execution of the machine instructions further performs the operations of:

providing a user interface to enable an administrator to define file type-to-application mapping information that maps each of a plurality of source data file types to one or more corresponding applications that may be used to load source data having that file type; and

in response to receiving the source data at the print server,

determining a file type of the source data;

determining an appropriate application to load on the print server to print the source data; and

initiating a print action to cause the application in combination with the print subsystem to generate the printer data.

31. The machine-readable media of claim 23, wherein execution of the machine instructions further performs the operation of providing a user interface to enable an administrator to define the file type-to-application mapping information and define application loading information to enable the applications to be loaded on the print server.

32. The machine-readable media of claim 31, wherein the user interface comprises a web page served from the web server.

33. The machine-readable media of claim 30, wherein an application may display message boxes and/or dialogs during an application printing process to inform a user of an error or warning or gather print parameter information from a user, and wherein execution of the machine instructions further performs the operation of automatically providing computer-generated input to handle any message boxes and/or dialogs that are launched by the application to generate the printer data.

34. The machine-readable media of claim 23, wherein execution of the machine instructions further performs the operation of generating print preview data corresponding to a print preview of the hard copy output and sending the print preview data to the originating device to be rendered on the originating device.

35. The machine-readable media of claim 34, wherein the data is sent to the originating device as a portable document format (PDF) document.

36. The machine-readable media of claim 23, wherein execution of the machine instructions further performs the operation of serving Web pages from the Web server to enable an administrator to view information pertaining to pending print jobs.

37. The machine-readable media of claim 23, wherein execution of the machine instructions further performs the operation of serving administration Web pages from the Web server to enable an administrator to view information pertaining to completed print jobs.

38. The machine-readable media of claim 37, wherein the administration Web pages enable the administrator to view completed print requests using a filter based on at least one of a date range, a specified owner, an account, and a specified printer.

39. The machine-readable media of claim 37, wherein the administration Web pages enable the administrator to view completed print requests using a filter that is generated in response to a plurality of search criteria entered by the administrator.

40. The machine-readable media of claim 23, wherein the operations of loading the source data and generating the printer data are performed using an operating system shell extension print mechanism.

41. A system to enable a user of an originating device to print source data on a target printer, comprising:

Web server means for serving one or more interactive Web pages to enable the user to select the source data to print and identify the target printer via a browser running on the originating device that renders the interactive Web page(s) and to receive a print request that includes the source data or indicia identifying the source data and identifies the target printer;

means for passing the source data or indicia identifying the source data from the Web server means to a print server computer;

means for loading an application or browser from which the source data can be printed on the print server computer along with the source data;

means for generating a print request to cause the application or browser to in combination with a print subsystem of an operating system running on the print server computer to generate printer data pertaining to the source data and the target printer; and

means for sending the printer data from the print server computer to the target printer.

42. The system of claim 41, wherein the originating device comprises one of a personal computer (PC), laptop computer, workstation, computer server, personal digital assistant device, pocket PC, cellular phone, or Internet appliance.

43. The system of claim 41, wherein the source data comprises one of an application file, image, or a Web page.

44. The system of claim 41, wherein the source data comprises an application file that the user is enabled to select via a file browse operation initiated by a corresponding control in an interactive Web page served by the Web server means, said application file comprising a file that is either stored on the originating device or stored on a device that may be accessed by the originating device via a network.

45. The system of claim 41, wherein the source data comprises an image file that is rendered on a browser running on the print server computer and the means for generating a print request invokes a browser print command to cause the browser to submit graphical data pertaining to the image to the print subsystem.

46. The system of claim 41, wherein the indicia identifying the source data comprises a URL (uniform resource locator) address corresponding to a Web page, and the means for loading an application or browser loads a Web browser and passes the URL address to the Web browser so that the Web browser can navigate to the Web page, and the means for generating a print request activates a Web browser print command to cause the Web browser to send data corresponding to the Web page to the print subsystem to generate the printer data.

47. The system of claim 41, wherein the Web server means further performs the operation of serving an interactive Web page providing print status information to enable the user to monitor a source data print request submitted by the user.

48. The system of claim 41, wherein the Web server means further performs the operations of:

serving one or more Web pages to enable an administrator to define file type-to-application mapping information that maps each of a plurality of source data file types to one or more corresponding applications that may be used to load source data having that file type; and

in response to receiving the source data at the print server computer, the means for loading an application or browser performs the operations of:

determining a file type of the source data;

determining an appropriate application to load on the print server computer to open the source data; and

the means for generating a print request invokes an application print command to cause the application to submit data corresponding to the source data to the print subsystem to generate the printer data.

49. The system of claim 48, wherein said one or more Web pages further enable an administrator to define the file type-to-application mapping information and define application loading information to enable the applications to be loaded on the print server computer.

50. The system of claim 48, wherein an application may display message boxes and/or dialogs during an application printing process to inform a user of an error or warning or gather print parameter information from a user, further comprising a handle windows means that automatically provides computer-generated input to handle any message boxes and/or dialogs that are invoked when generating the printer data.

51. The system of claim 41, further comprising a print preview means that generates data that may be used to render a print preview of what the hard copy output will look like.

52. The system of claim 51, wherein the data to render the print preview comprises a portable document format (PDF) document.

53. The system of claim 41, wherein the Web server means further serves administration Web pages to enable an administrator to view information pertaining to pending print jobs.

54. The system of claim 41, wherein the Web server means further serves administration Web pages to enable an administrator to view information pertaining to completed print jobs.

55. The system of claim 54, wherein the administration Web pages enable the administrator to view completed print requests using a filter based on at least one of a date range, a specified owner, an account and a specified printer.

56. The system of claim 54, wherein the administration Web pages enable the administrator to view completed print requests using a filter that is generated in response to a plurality of search criteria entered by the administrator.

57. A method to enable a user of an originating device to print source data on a target printer, comprising:

providing data to the originating device from which a user interface can be rendered to enable the user to select the source data to print and identify the target printer;

receiving the source data from the originating device and providing the source data to a print server;

determining whether the source data comprises a printer file, and if it does, submitting the source data to a print spooler; and

routing an output of the print spooler to the target printer.

58. The method of claim 57, wherein the data provided to generate the user interface comprises a Web page served by a Web server that is operatively linked in communication with the print server.

59. A machine readable media on which a plurality of machine instructions are stored that when executed by a computing machine enable a user of an originating device to print a hard copy output on a target printer pertaining to source data selected by the user by performing the operations of:

serving Web-based data from a Web server to the originating device to enable a user interface to be rendered on the originating device, said user interfaced having interactive controls to enable the user to select the source data

to print and identify the target printer from a list of printers that may be selected to print the hard copy output;

receiving the source data from the originating device at the Web server;

passing the source data to a print server;

determining whether the source data comprises a printer file, and if it does,

submitting the source data to a print spooler; and

routing an output of the print spooler to the target printer.

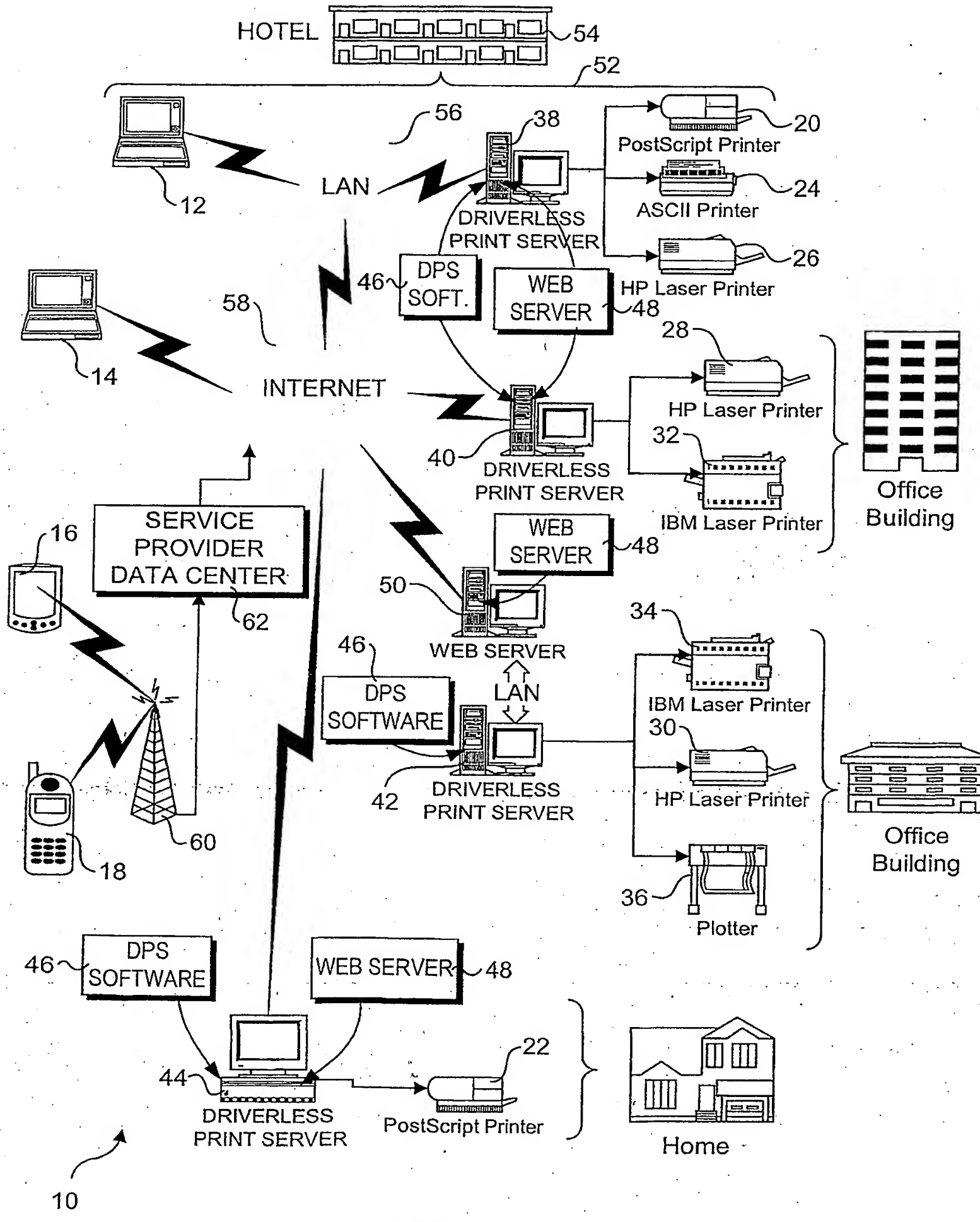

HOTEL
54
52
56
38
20
PostScript Printer
LAN
12
DRIVERLESS
PRINT SERVER
24
ASCII Printer
46
DPS
SOFT.
WEB
SERVER
48
26
HP Laser Printer
58
28
14
INTERNET
HP Laser Printer
40
32
DRIVERLESS
PRINT SERVER
IBM Laser Printer
Office
Building
16
SERVICE
PROVIDER
DATA CENTER
62
WEB
SERVER
48
50
WEB SERVER
34
46
DPS
SOFTWARE
LAN
IBM Laser Printer
30
42
DRIVERLESS
PRINT SERVER
HP Laser Printer
Office
Building
60
18
36
Plotter
46
DPS
SOFTWARE
WEB SERVER
48
22
44
DRIVERLESS
PRINT SERVER
PostScript Printer
Home
10

FIG. 1

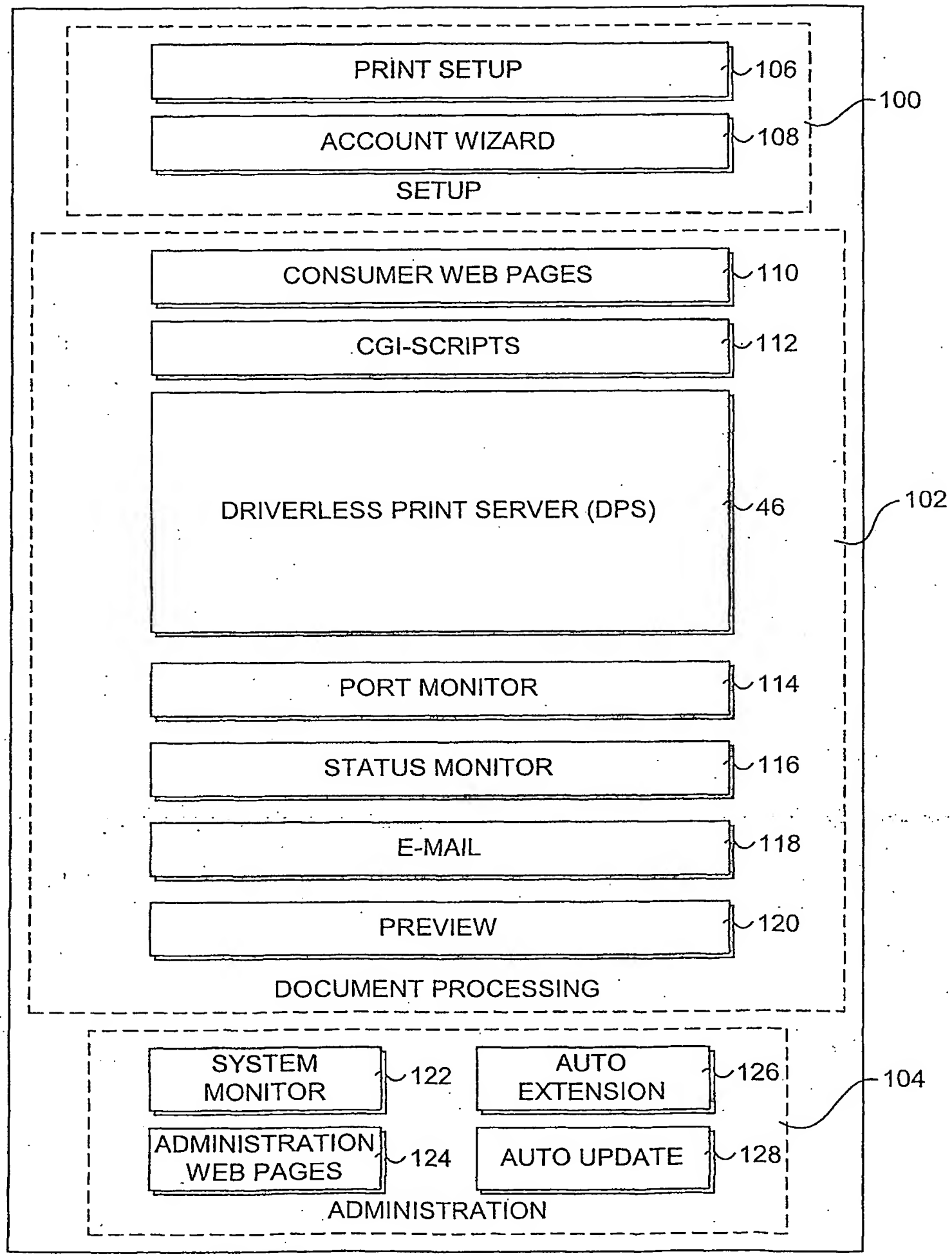

PRINT SETUP
106
ACCOUNT WIZARD
108
SETUP
100
CONSUMER WEB PAGES
110
CGI-SCRIPTS
112
DRIVERLESS PRINT SERVER (DPS)
46
102
PORT MONITOR
114
STATUS MONITOR
116
E-MAIL
118
PREVIEW
120
DOCUMENT PROCESSING
SYSTEM MONITOR
122
AUTO EXTENSION
126
ADMINISTRATION WEB PAGES
124
AUTO UPDATE
128
ADMINISTRATION
104

FIG. 2

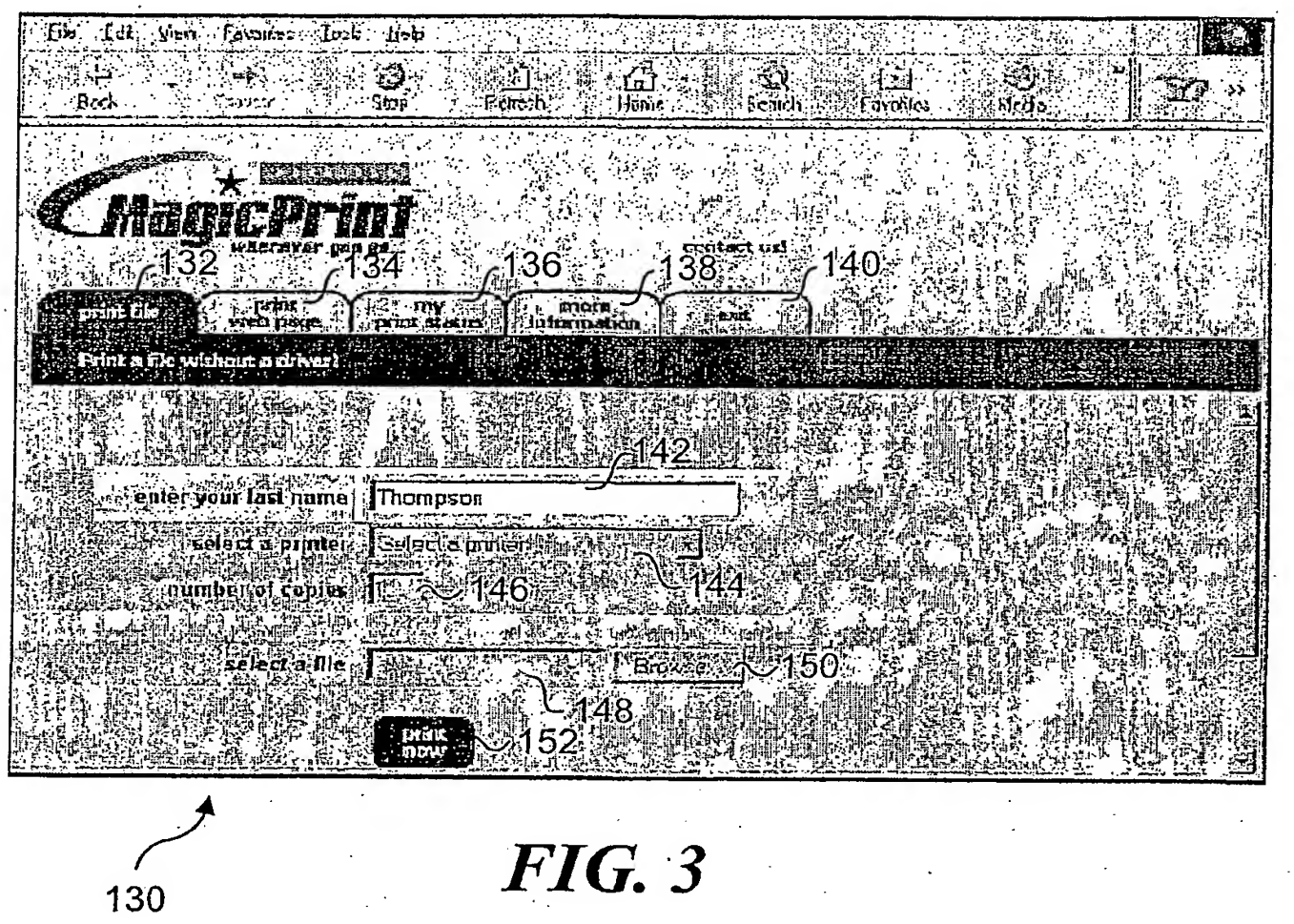

MagicPrint
132
134
136
138
140
print file
print web page
my print status
more information
exit
Print a file without a driver!
142
enter your last name
Thompson
select a printer
Select a printer
144
number of copies
146
select a file
Browse...
150
148
print now
152
130

FIG. 3

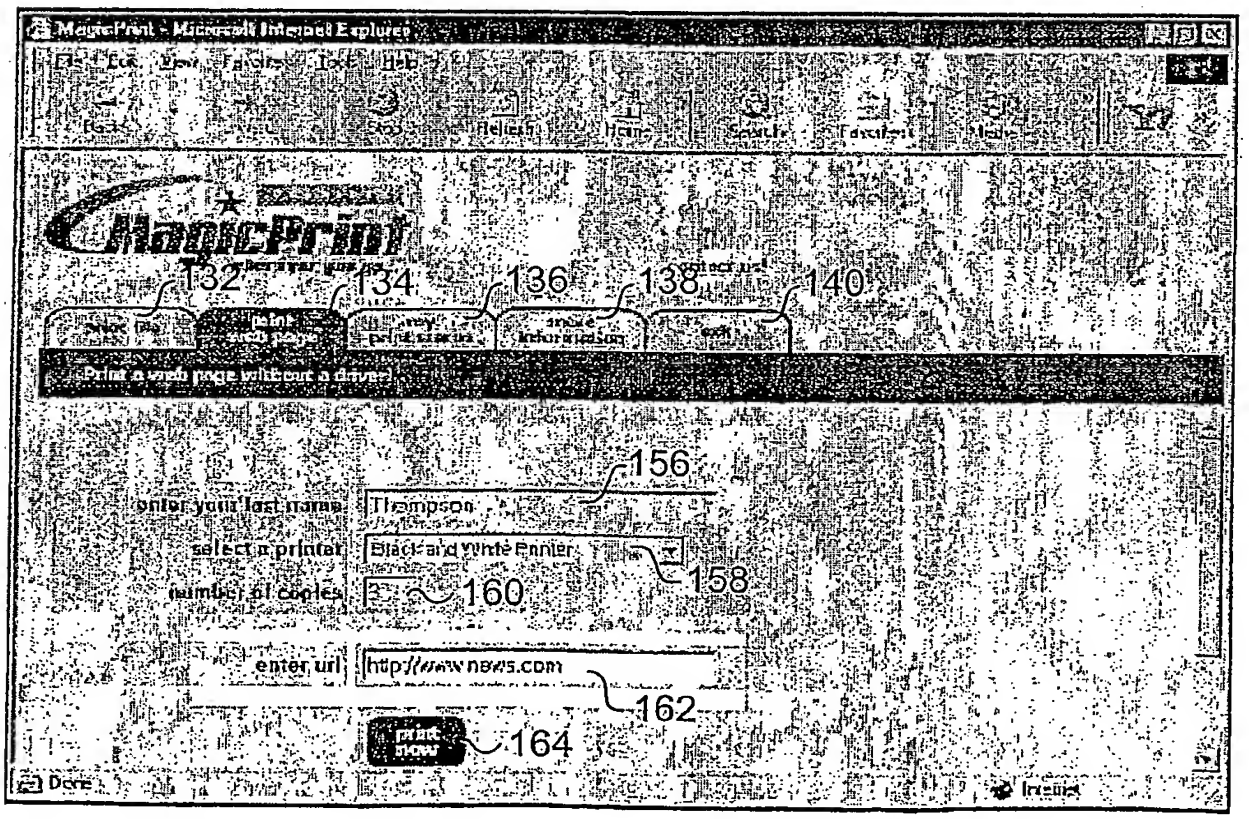

MagicPrint - Microsoft Internet Explorer
MagicPrint
132
134
136
138
140
Print a web page without a driver!
156
enter your last name
Thompson
select a printer
Black and White Printer
158
number of copies
160
enter url
http://www.news.com
162
print now
164
Done
Internet
154

FIG. 4

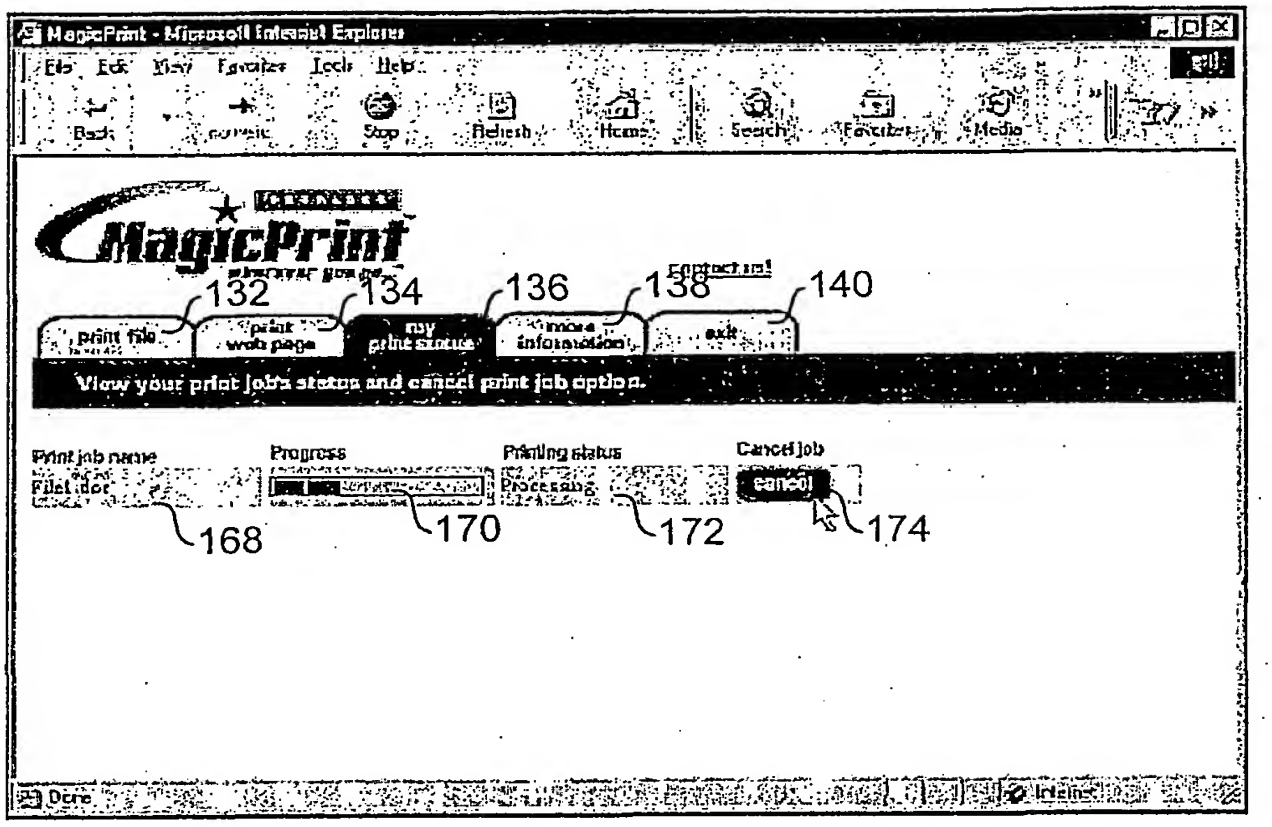

MagicPrint - Microsoft Internet Explorer
MagicPrint
print file
print web page
my print status
invoice information
exit
View your print jobs status and cancel print job options.
Print job name
Progress
Printing status
Cancel job
Filetitle
Processing
cancel
132
134
136
138
140
168
170
172
174
166

FIG. 5

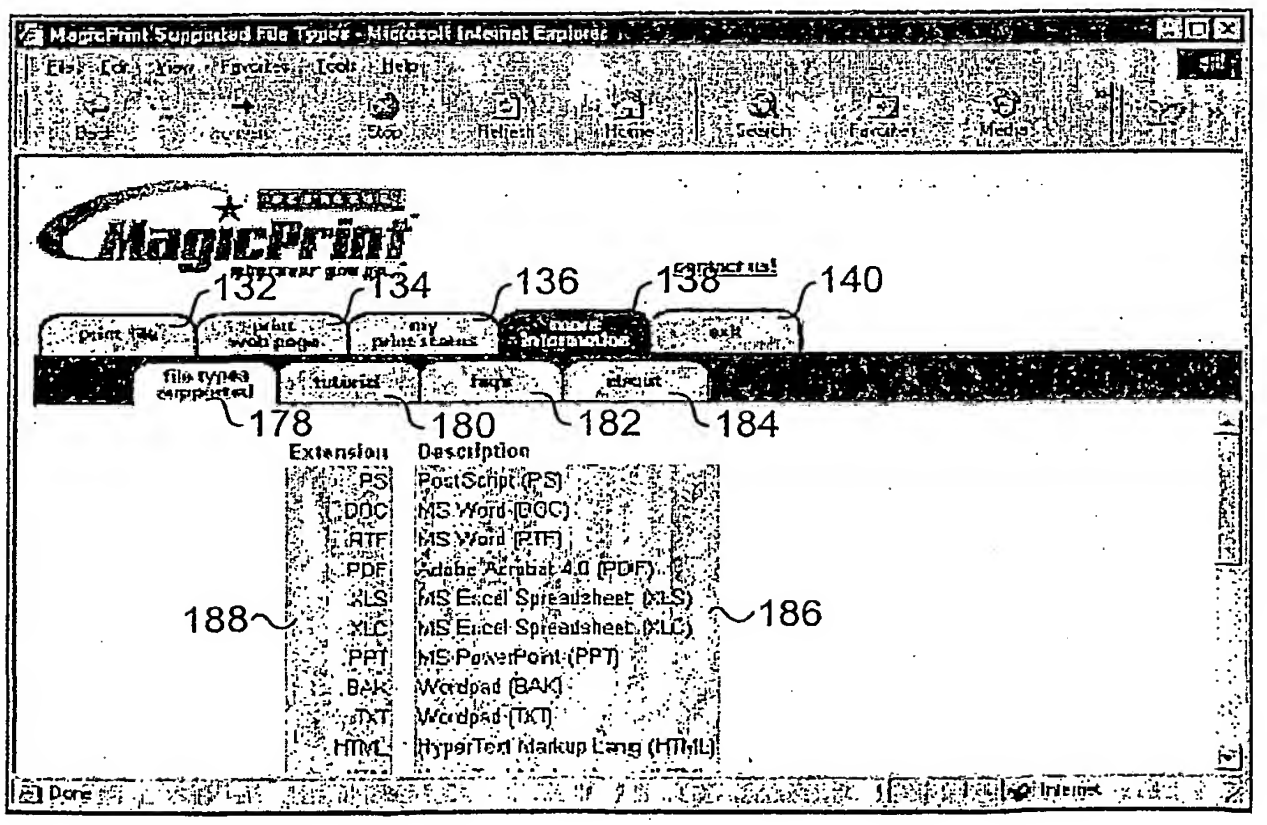

MagicPrint Supported File Types - Microsoft Internet Explorer
MagicPrint
print file
print web page
my print status
invoice information
exit
file types supported
tutorial
faqs
about
132
134
136
138
140
178
180
182
184
Extension
Description
PS
PostScript (PS)
DOC
MS Word (DOC)
RTF
MS Word (RTF)
PDF
Adobe Acrobat 4.0 (PDF)
XLS
MS Excel Spreadsheet (XLS)
XLC
MS Excel Spreadsheet (XLC)
PPT
MS PowerPoint (PPT)
BAK
Wordpad (BAK)
TXT
Wordpad (TXT)
HTML
HyperText Markup Lang (HTML)
188
186
176

FIG. 6

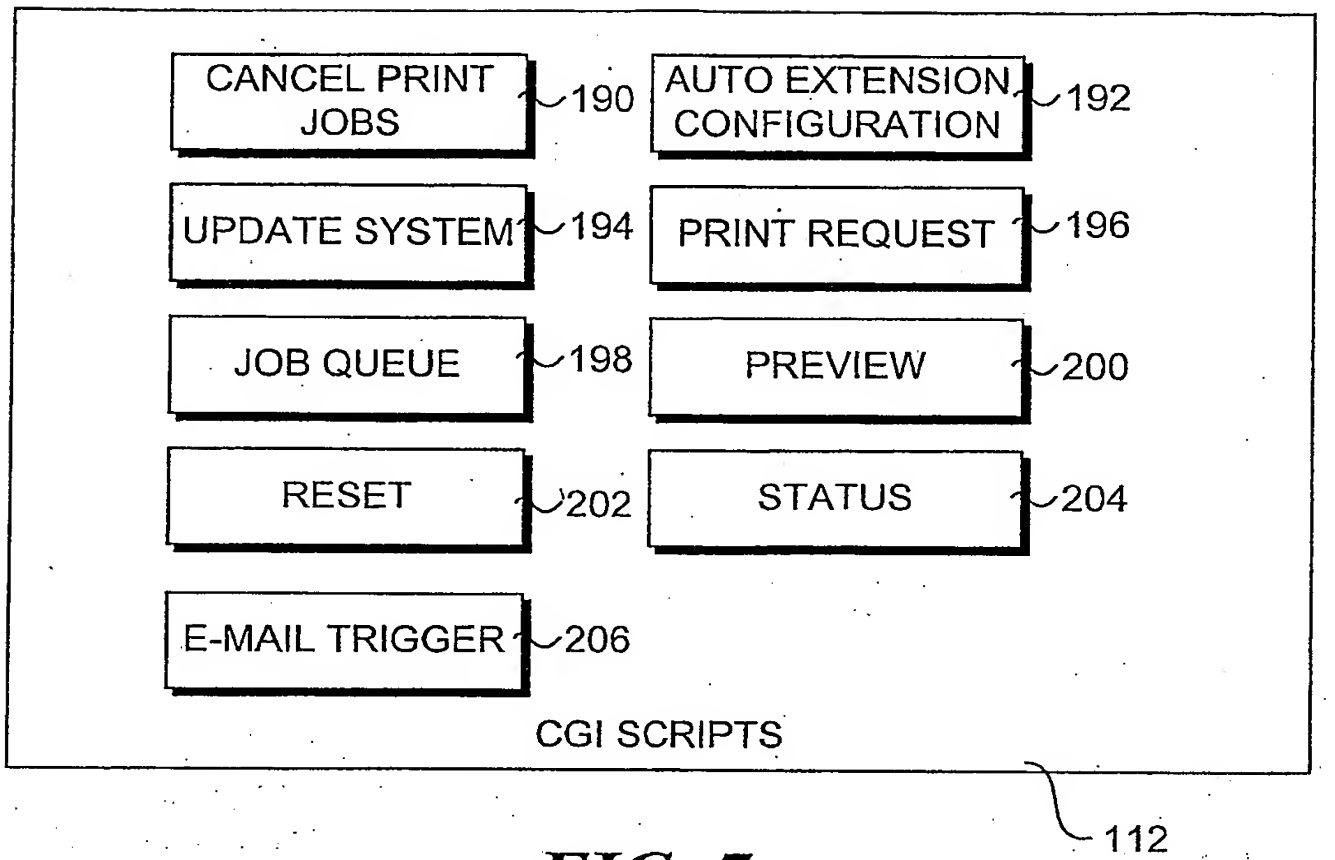

CANCEL PRINT JOBS
190
AUTO EXTENSION CONFIGURATION
192
UPDATE SYSTEM
194
PRINT REQUEST
196
JOB QUEUE
198
PREVIEW
200
RESET
202
STATUS
204
E-MAIL TRIGGER
206
CGI SCRIPTS
112

FIG. 7

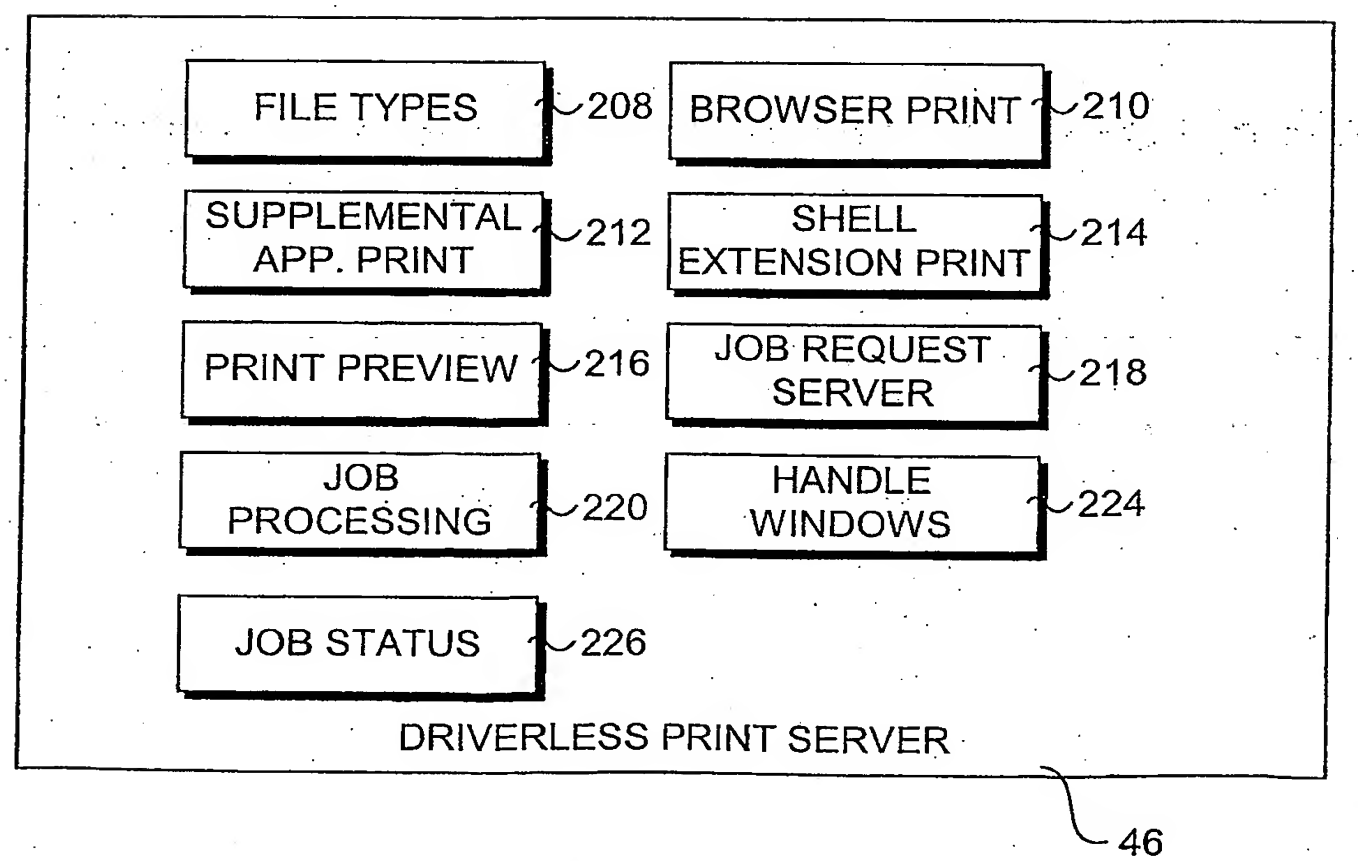

FILE TYPES
208
BROWSER PRINT
210
SUPPLEMENTAL APP. PRINT
212
SHELL EXTENSION PRINT
214
PRINT PREVIEW
216
JOB REQUEST SERVER
218
JOB PROCESSING
220
HANDLE WINDOWS
224
JOB STATUS
226
DRIVERLESS PRINT SERVER
46

FIG. 8

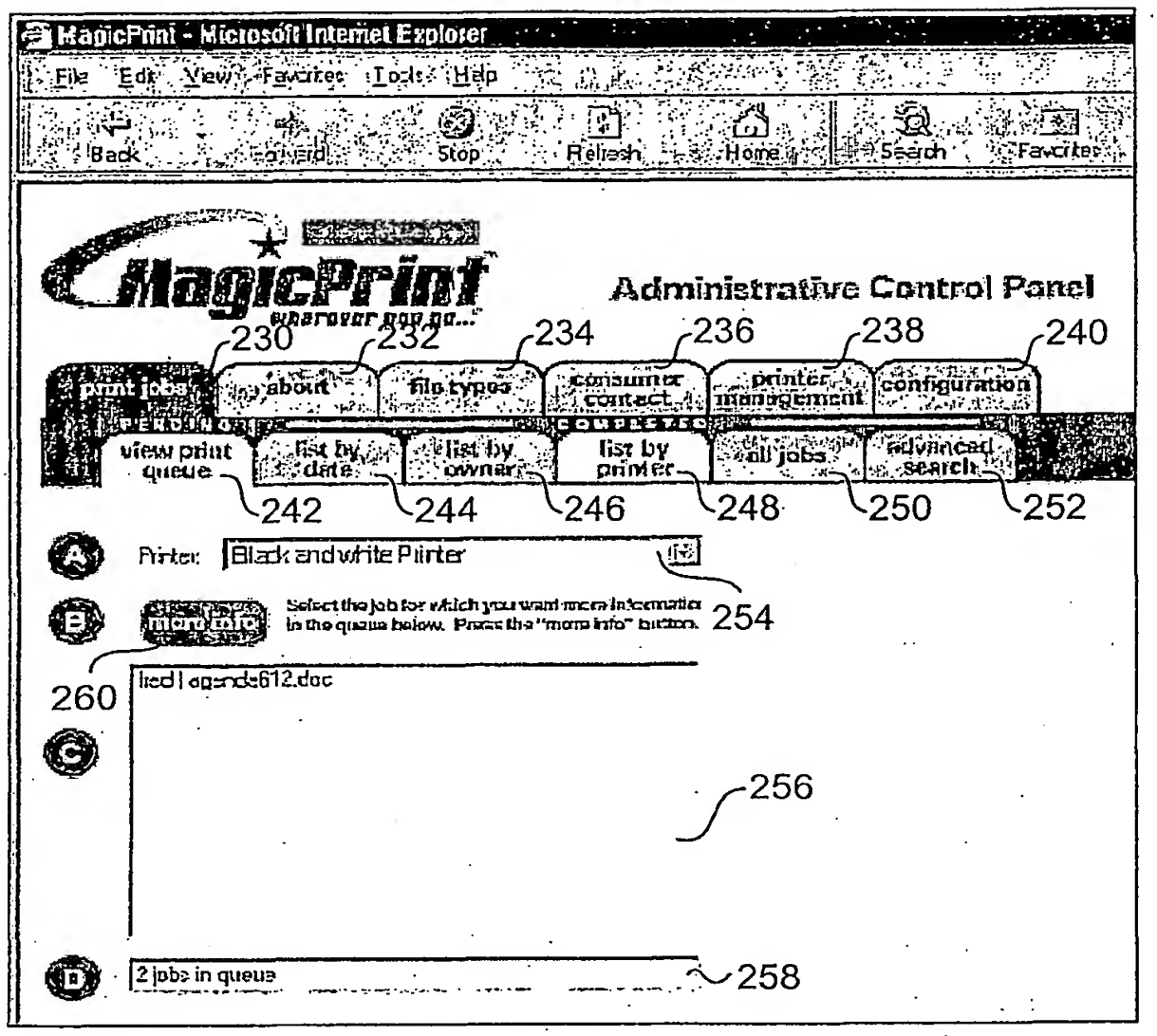

MagicPrint - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites
MagicPrint
wherever you go...
Administrative Control Panel
230
232
234
236
238
240
print jobs
about
file types
consumer contact
printer management
configuration
OPERATION
CONFIGURE
view print queue
list by date
list by owner
list by printer
all jobs
advanced search
242
244
246
248
250
252
A
Printer:
Black and white Printer
254
B
more info
Select the job for which you want more information in the queue below. Press the "more info" button.
260
lied | agenda612.doc
C
256
D
2 jobs in queue
258
228

FIG. 9

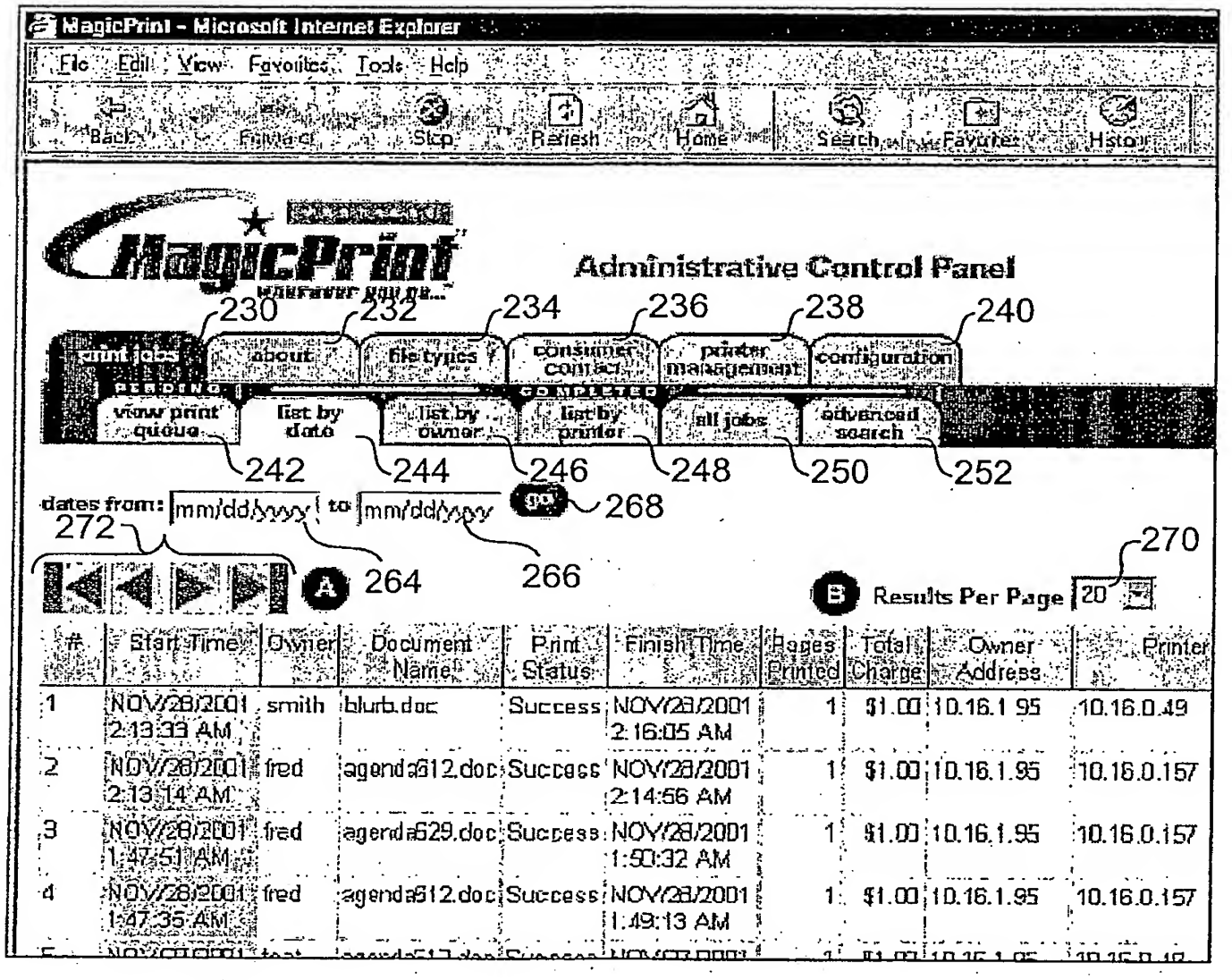

MagicPrint - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History
MagicPrint
Administrative Control Panel
print jobs
about
file types
consumer connect
printer management
configuration
PENDING
COMPLETED
view print queue
list by date
list by owner
list by printer
all jobs
advanced search
230
232
234
236
238
240
242
244
246
248
250
252
dates from: mm/dd/yyyy to mm/dd/yyyy
GO
268
272
264
266
270
A
B
Results Per Page 20
Start Time Owner Document Name Print Status Finish Time Pages Printed Total Charge Owner Address Printer
1 NOV/28/2001 2:13:33 AM smith blurb.doc Success NOV/28/2001 2:16:05 AM 1 $1.00 10.16.1.95 10.16.0.49
2 NOV/28/2001 2:13:14 AM fred agenda612.doc Success NOV/28/2001 2:14:56 AM 1 $1.00 10.16.1.95 10.16.0.157
3 NOV/28/2001 1:47:51 AM fred agenda629.doc Success NOV/28/2001 1:50:32 AM 1 $1.00 10.16.1.95 10.16.0.157
4 NOV/28/2001 1:47:35 AM fred agenda612.doc Success NOV/28/2001 1:49:13 AM 1 $1.00 10.16.1.95 10.16.0.157
262

FIG. 10

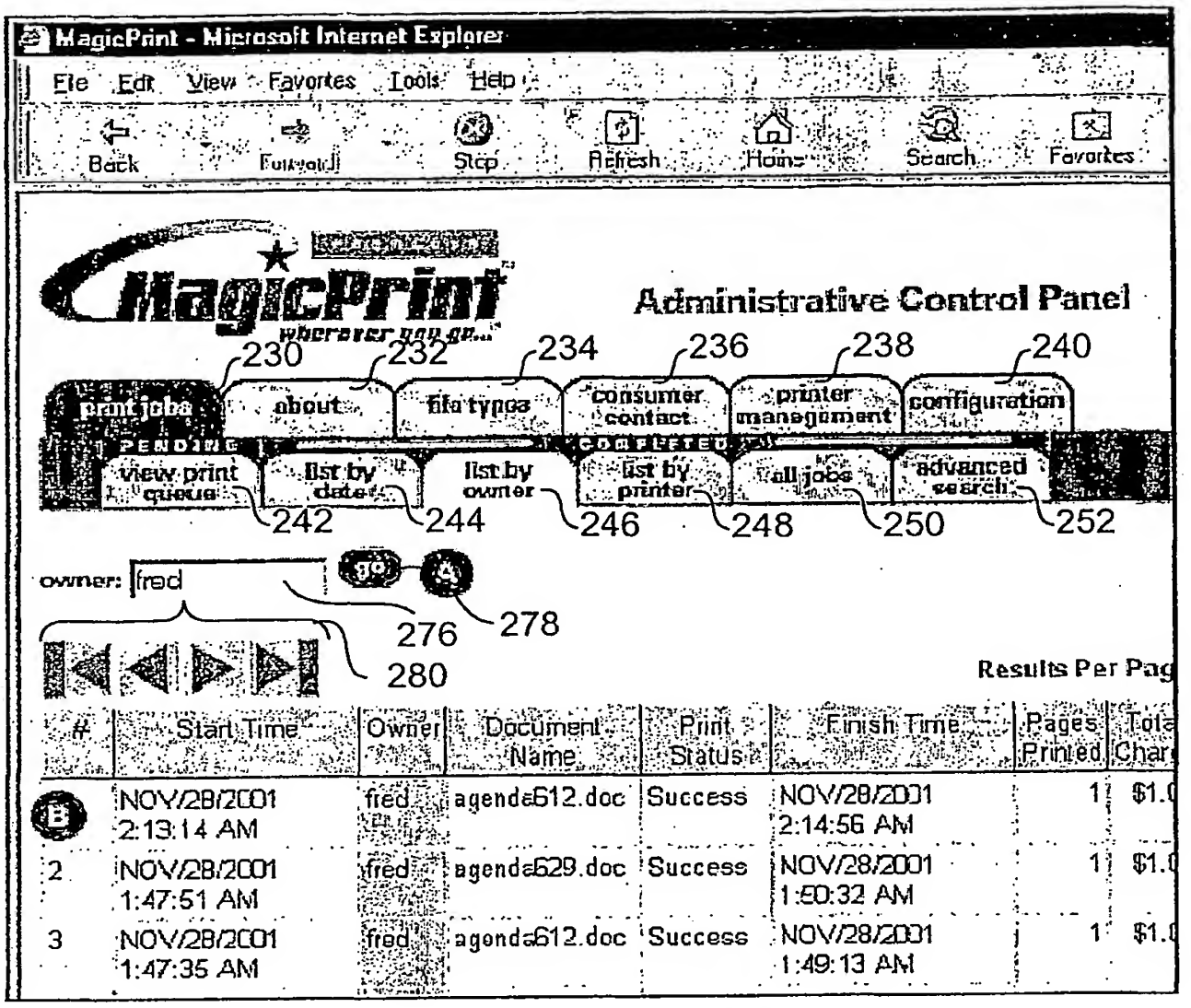

MagicPrint - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites
MagicPrint
wherever you go...
Administrative Control Panel
230
232
234
236
238
240
print jobs
about
file types
consumer contact
printer management
configuration
PENDING
COMPLETED
view print queue
list by date
list by owner
list by printer
all jobs
advanced search
242
244
246
248
250
252
owner: fred
276
278
280
Results Per Pag
Start Time Owner Document Name Print Status Finish Time Pages Printed Tot Char
1 NOV/28/2001 2:13:14 AM fred agenda612.doc Success NOV/28/2001 2:14:56 AM 1 $1.0
2 NOV/28/2001 1:47:51 AM fred agenda629.doc Success NOV/28/2001 1:50:32 AM 1 $1.0
3 NOV/28/2001 1:47:35 AM fred agenda612.doc Success NOV/28/2001 1:49:13 AM 1 $1.0
274

FIG. 11

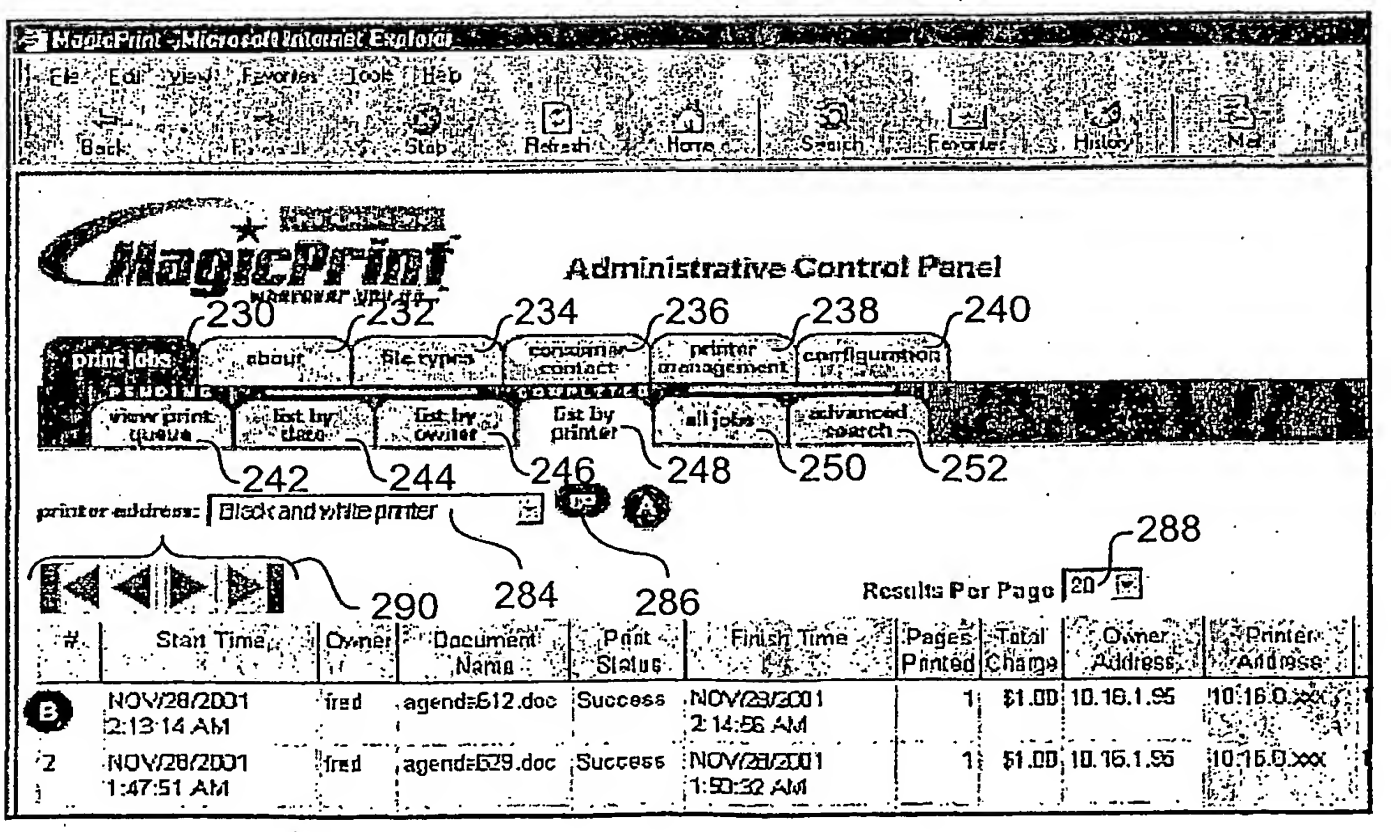

MagicPrint - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Stop Refresh Home Search Favorites History Mail
MagicPrint
Administrative Control Panel
230
232
234
236
238
240
print jobs
about
file types
consumer contact
printer management
configuration
PENDING
COMPLETED
view print queue
list by date
list by owner
list by printer
all jobs
advanced search
242
244
246
248
250
252
printer address: Black and white printer
284
286
288
290
Results Per Page 20
Start Time Owner Document Name Print Status Finish Time Pages Printed Total Charge Owner Address Printer Address
1 NOV/28/2001 2:13:14 AM fred agenda612.doc Success NOV/28/2001 2:14:56 AM 1 $1.00 10.16.1.95 10.16.0.xxx
2 NOV/28/2001 1:47:51 AM fred agenda629.doc Success NOV/28/2001 1:50:32 AM 1 $1.00 10.16.1.95 10.16.0.xxx
282

FIG. 12

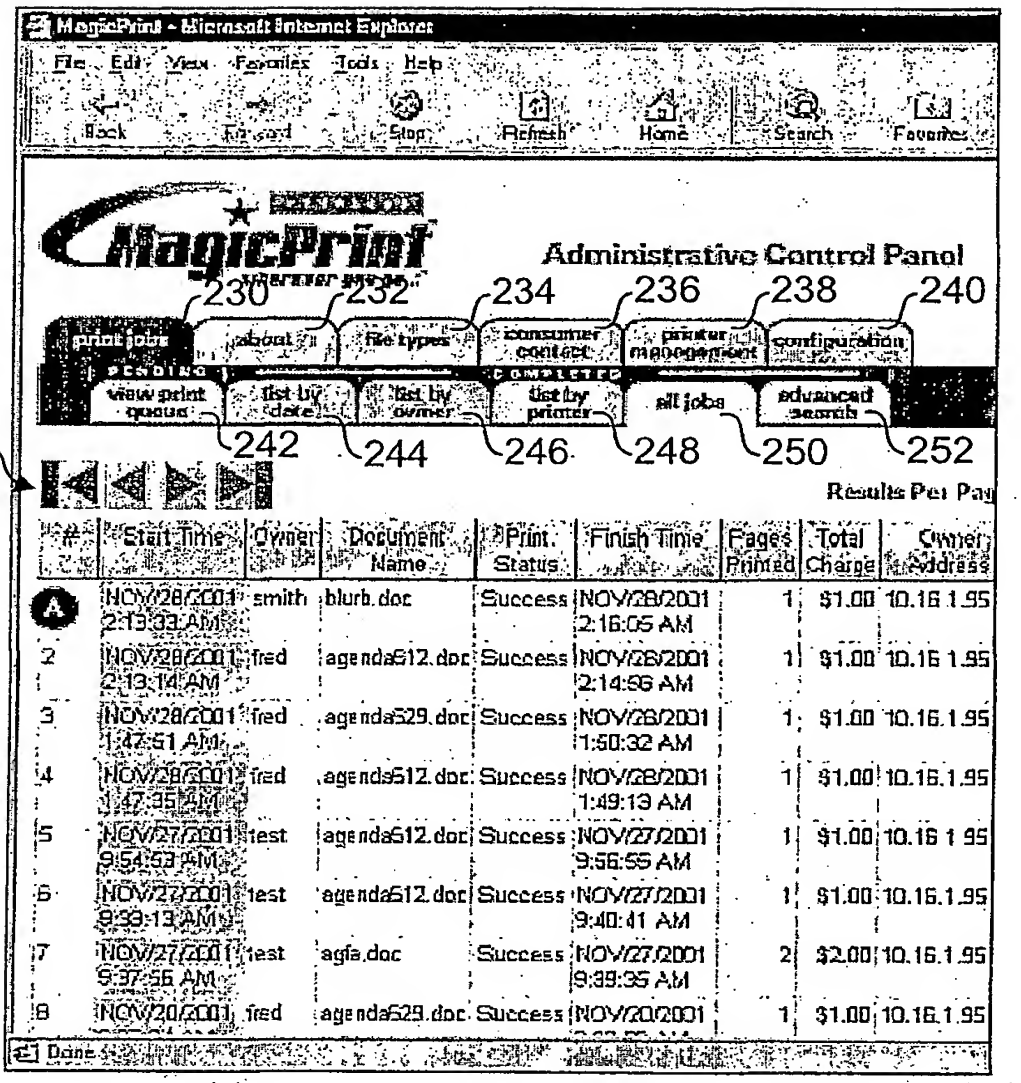
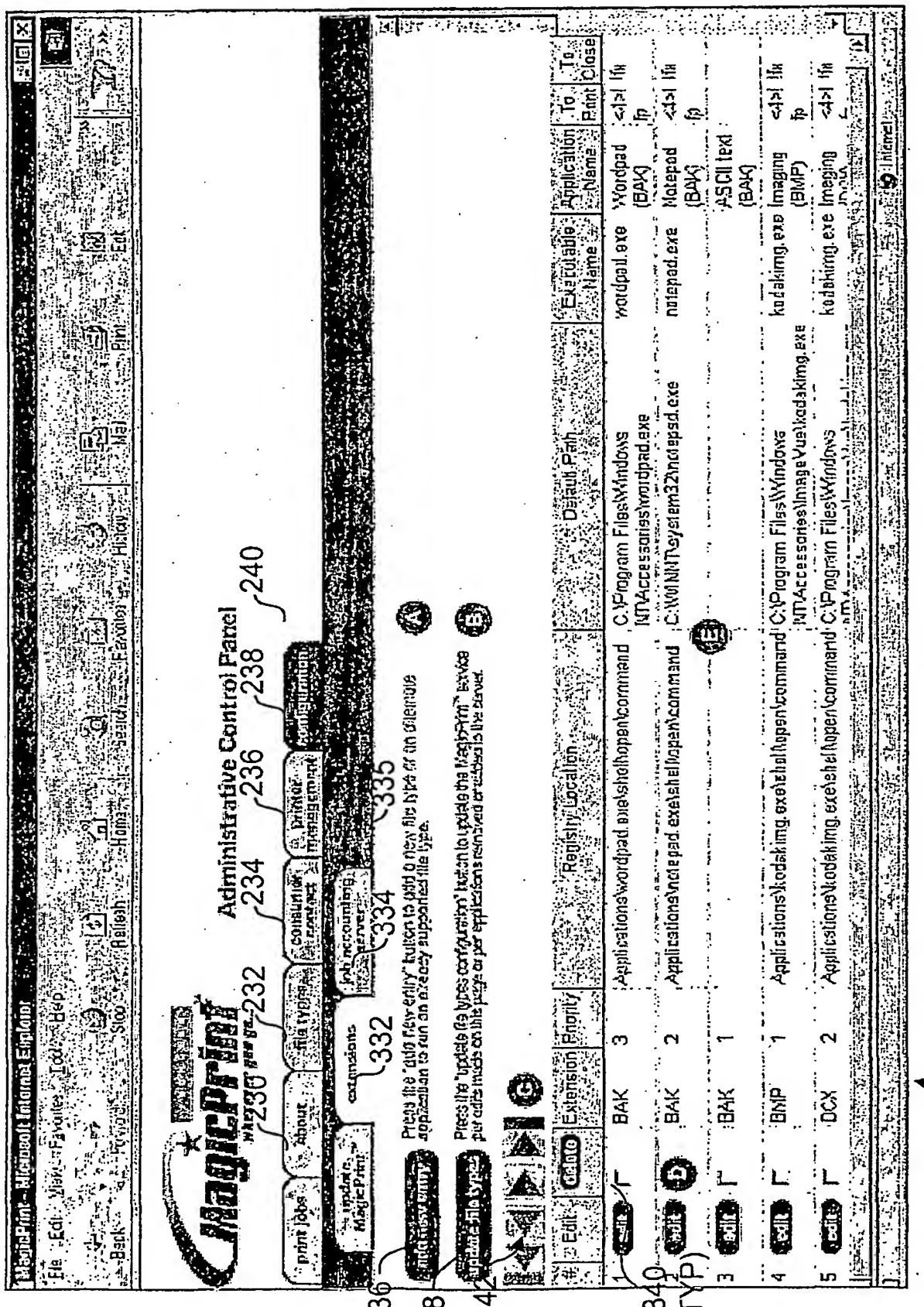

MagicPrint - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites
MagicPrint
Administrative Control Panel
230 232 234 236 238 240
print jobs about file types consumer content printer management configuration
PENDING COMPLETED
view print queue list by date list by owner list by printer all jobs advanced search
242 244 246 248 250 252
294
Results Per Pag
Start Time Owner Document Name Print Status Finish Time Pages Printed Total Charge Owner IP Address
A NOV/28/2001 2:13:33 AM smith blurb.doc Success NOV/28/2001 2:16:05 AM 1 $1.00 10.16.1.95
2 NOV/28/2001 2:13:14 AM fred agenda612.doc Success NOV/28/2001 2:14:56 AM 1 $1.00 10.16.1.95
3 NOV/28/2001 1:47:51 AM fred agenda529.doc Success NOV/28/2001 1:50:32 AM 1 $1.00 10.16.1.95
4 NOV/28/2001 1:47:35 AM fred agenda612.doc Success NOV/28/2001 1:49:13 AM 1 $1.00 10.16.1.95
5 NOV/27/2001 9:54:53 AM test agenda612.doc Success NOV/27/2001 9:56:55 AM 1 $1.00 10.16.1.95
6 NOV/27/2001 9:39:13 AM test agenda612.doc Success NOV/27/2001 9:40:41 AM 1 $1.00 10.16.1.95
7 NOV/27/2001 9:37:56 AM test agfa.doc Success NOV/27/2001 9:39:35 AM 2 $2.00 10.16.1.95
8 NOV/20/2001 fred agenda529.doc Success NOV/20/2001 1 $1.00 10.16.1.95
Done
292

FIG. 13


MagicPrint
Administrative Control Panel
print jobs
About
file types
consumables
printer management
extensions
job accounting
server
Edit
Delete
Extension
Priority
Registry Location
Executable Name
Application Name
Default Path
Close
230
232
234
236
238
240
332
334
335
336
338
340
342
(TYP)
330

12/16

FIG. 16

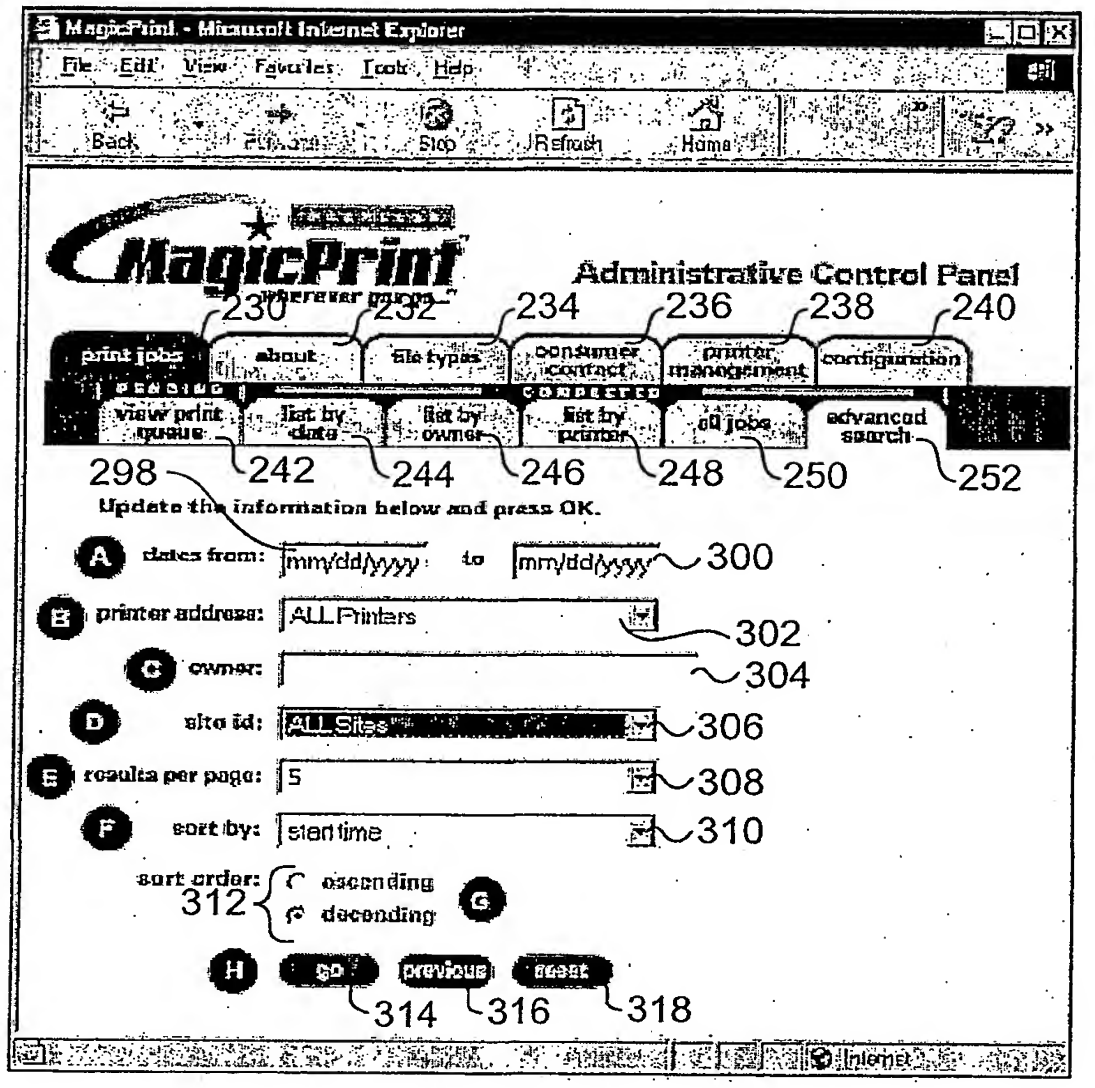

MagicPrint - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Stop Refresh Home
MagicPrint
Administrative Control Panel
print jobs
about
file types
consumer contract
printer management
configuration
PENDING
CONFIRMED
view print queue
list by date
list by owner
list by printer
all jobs
advanced search
230
232
234
236
238
240
242
244
246
248
250
252
298
Update the information below and press OK.
A dates from: mm/dd/yyyy to mm/dd/yyyy 300
B printer address: ALL Printers 302
C owner: 304
D site id: ALL Sites 306
E results per page: 5 308
F sort by: start time 310
sort order: 312
ascending
descending
G
H go previous reset
314
316
318
Internet
296

FIG. 14

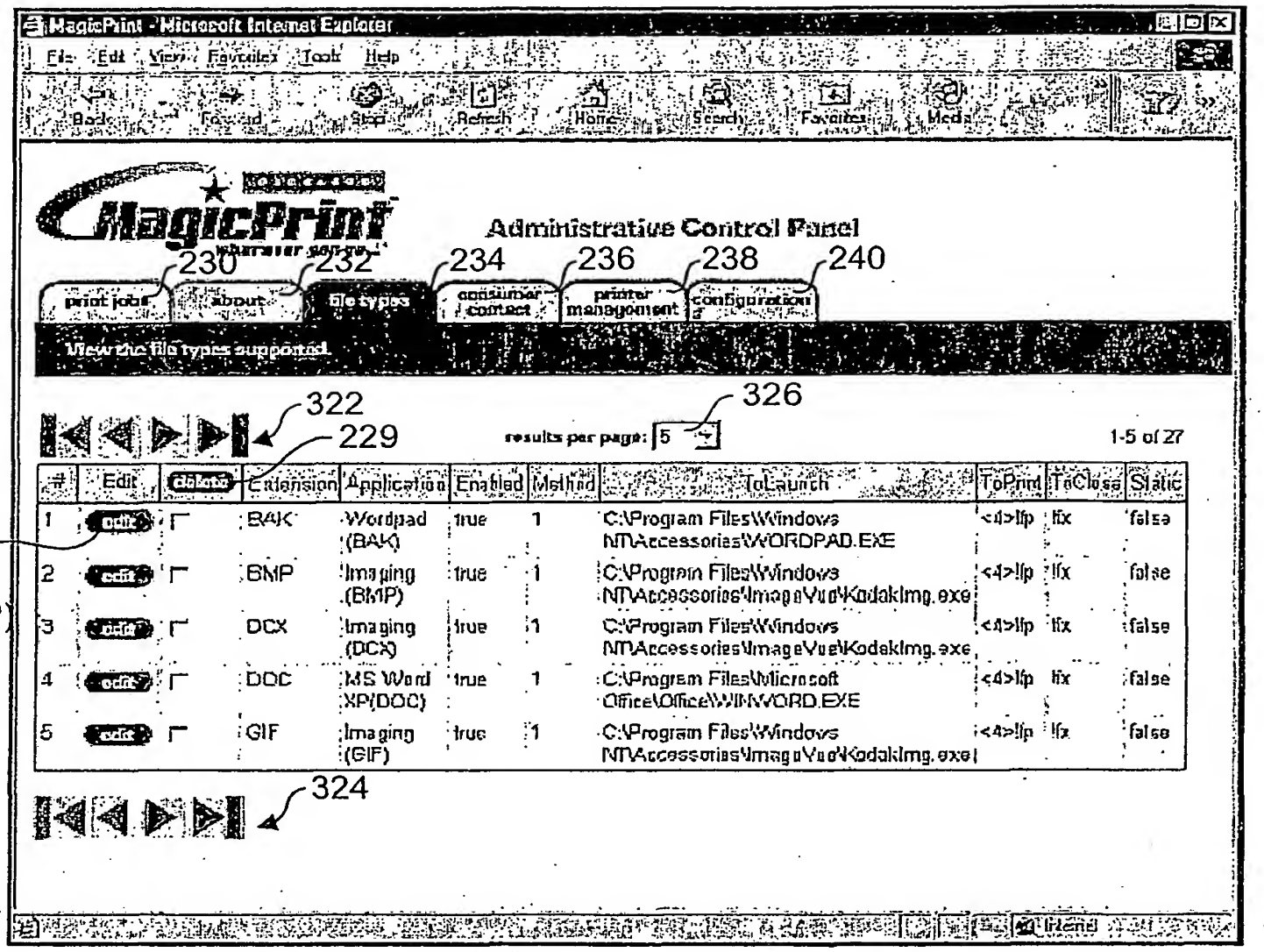
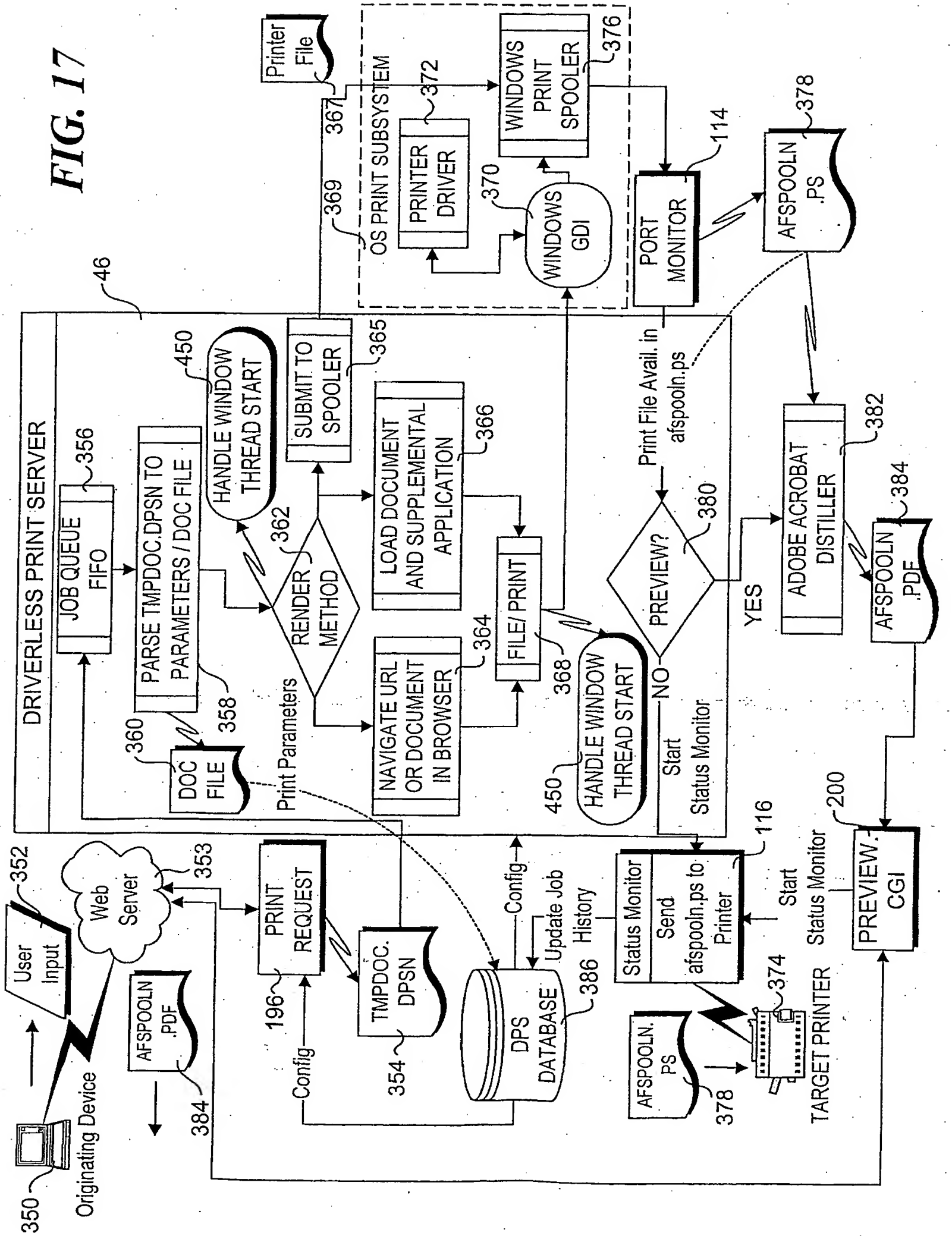

MagicPrint - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites Media
MagicPrint
Administrative Control Panel
230
232
234
236
238
240
print jobs
about
file types
consumer contact
printer management
configuration
View the file types supported.
322
229
326
results per page: 5
1-5 of 27
Edit Delete Extension Application Enabled Method ToLaunch ToPrint ToClose Static
1 edit BAK Wordpad (BAK) true 1 C:\Program Files\Windows NT\Accessories\WORDPAD.EXE <4>!fp !fx false
2 edit BMP Imaging (BMP) true 1 C:\Program Files\Windows NT\Accessories\ImageVue\KodakImg.exe <4>!fp !fx false
3 edit DCX Imaging (DCX) true 1 C:\Program Files\Windows NT\Accessories\ImageVue\KodakImg.exe <4>!fp !fx false
4 edit DOC MS Word XP(DOC) true 1 C:\Program Files\Microsoft Office\Office\WINWORD.EXE <4>!fp !fx false
5 edit GIF Imaging (GIF) true 1 C:\Program Files\Windows NT\Accessories\ImageVue\KodakImg.exe <4>!fp !fx false
324
328 (TYP)
320

FIG. 15

FIG. 17


Printer File
367
OS PRINT SUBSYSTEM
PRINTER DRIVER
372
WINDOWS PRINT SPOOLER
376
369
WINDOWS GDI
370
PORT MONITOR
114
AFSPOOLN .PS
378
46
DRIVERLESS PRINT SERVER
JOB QUEUE FIFO
356
PARSE TMPDOC.DPSN TO PARAMETERS / DOC FILE
450
HANDLE WINDOW THREAD START
SUBMIT TO SPOOLER
365
LOAD DOCUMENT AND SUPPLEMENTAL APPLICATION
366
362
RENDER METHOD
Print Parameters
364
FILE/ PRINT
Print File Avail. in afspooln.ps
PREVIEW?
380
YES
ADOBE ACROBAT DISTILLER
382
AFSPOOLN .PDF
384
NAVIGATE URL OR DOCUMENT IN BROWSER
368
NO
HANDLE WINDOW THREAD START
Start Status Monitor
360
DOC FILE
358
352
User Input
Web Server
353
PRINT REQUEST
196
Config
TMPDOC. DPSN
354
Config
Update Job History
DPS DATABASE
386
Status Monitor
Send afspooln.ps to Printer
116
Start Status Monitor
PREVIEW. CGI
200
AFSPOOLN .PDF
384
AFSPOOLN. PS
378
374
TARGET PRINTER
350
Originating Device

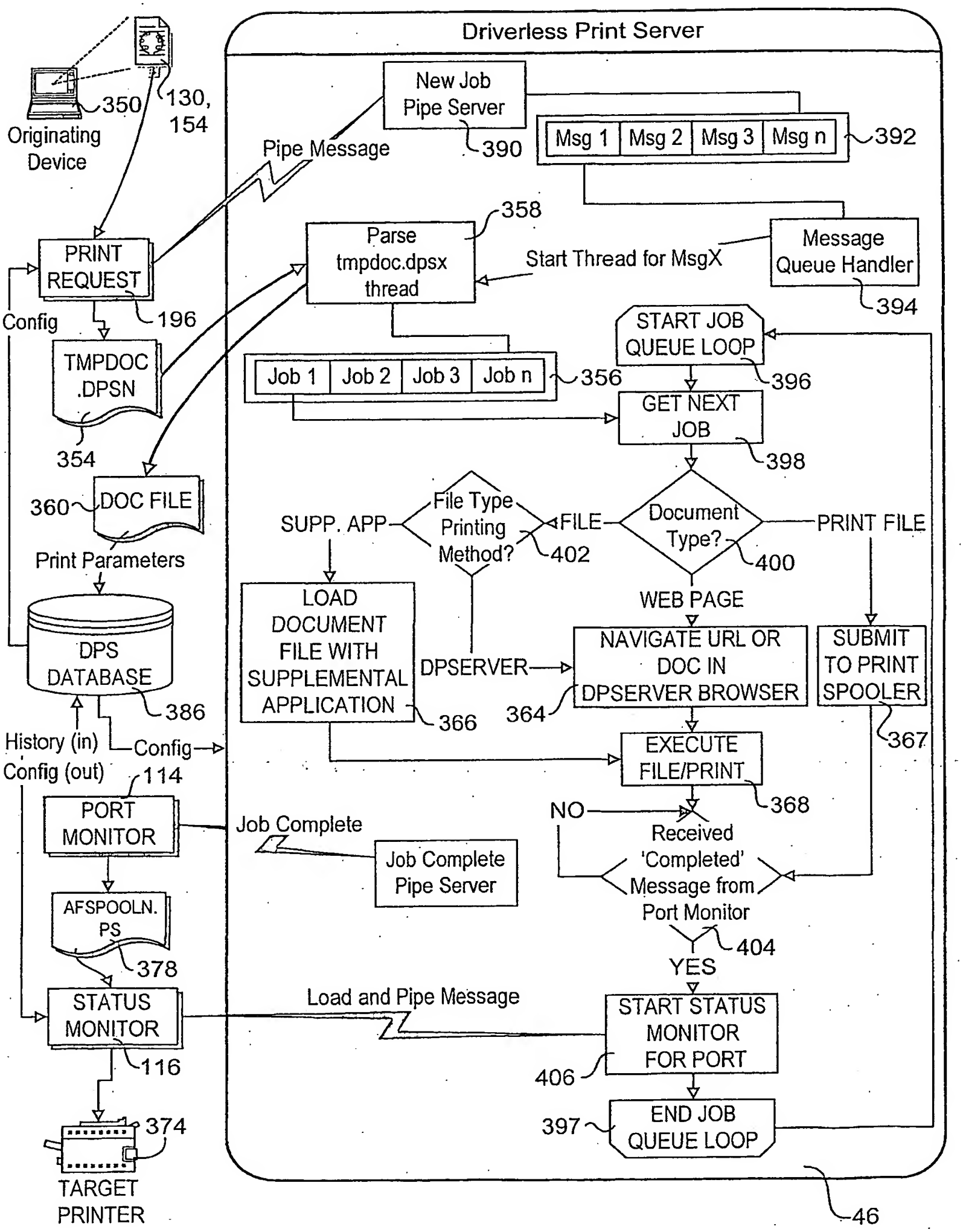

Driverless Print Server
Originating Device
350
130, 154
New Job Pipe Server
390
Pipe Message
Msg 1
Msg 2
Msg 3
Msg n
392
PRINT REQUEST
196
Config
Parse tmpdoc.dpsx thread
358
Start Thread for MsgX
Message Queue Handler
394
TMPDOC .DPSN
354
Job 1
Job 2
Job 3
Job n
356
START JOB QUEUE LOOP
396
GET NEXT JOB
398
360
DOC FILE
Print Parameters
SUPP. APP
File Type Printing Method?
FILE
402
Document Type?
400
PRINT FILE
WEB PAGE
DPS DATABASE
386
LOAD DOCUMENT FILE WITH SUPPLEMENTAL APPLICATION
366
DPSERVER
NAVIGATE URL OR DOC IN DPSERVER BROWSER
364
SUBMIT TO PRINT SPOOLER
367
History (in)
Config (out)
Config
114
EXECUTE FILE/PRINT
368
PORT MONITOR
Job Complete
Job Complete Pipe Server
NO
Received 'Completed' Message from Port Monitor
404
YES
AFSPOOLN. PS
378
STATUS MONITOR
116
Load and Pipe Message
START STATUS MONITOR FOR PORT
406
374
397
END JOB QUEUE LOOP
TARGET PRINTER
46

FIG. 18

Title	ClassName	MessageText	ExactMatch	MessageID	Wparam	Lparam
Printing Error	#32770	Before you can print	No	273	2	0

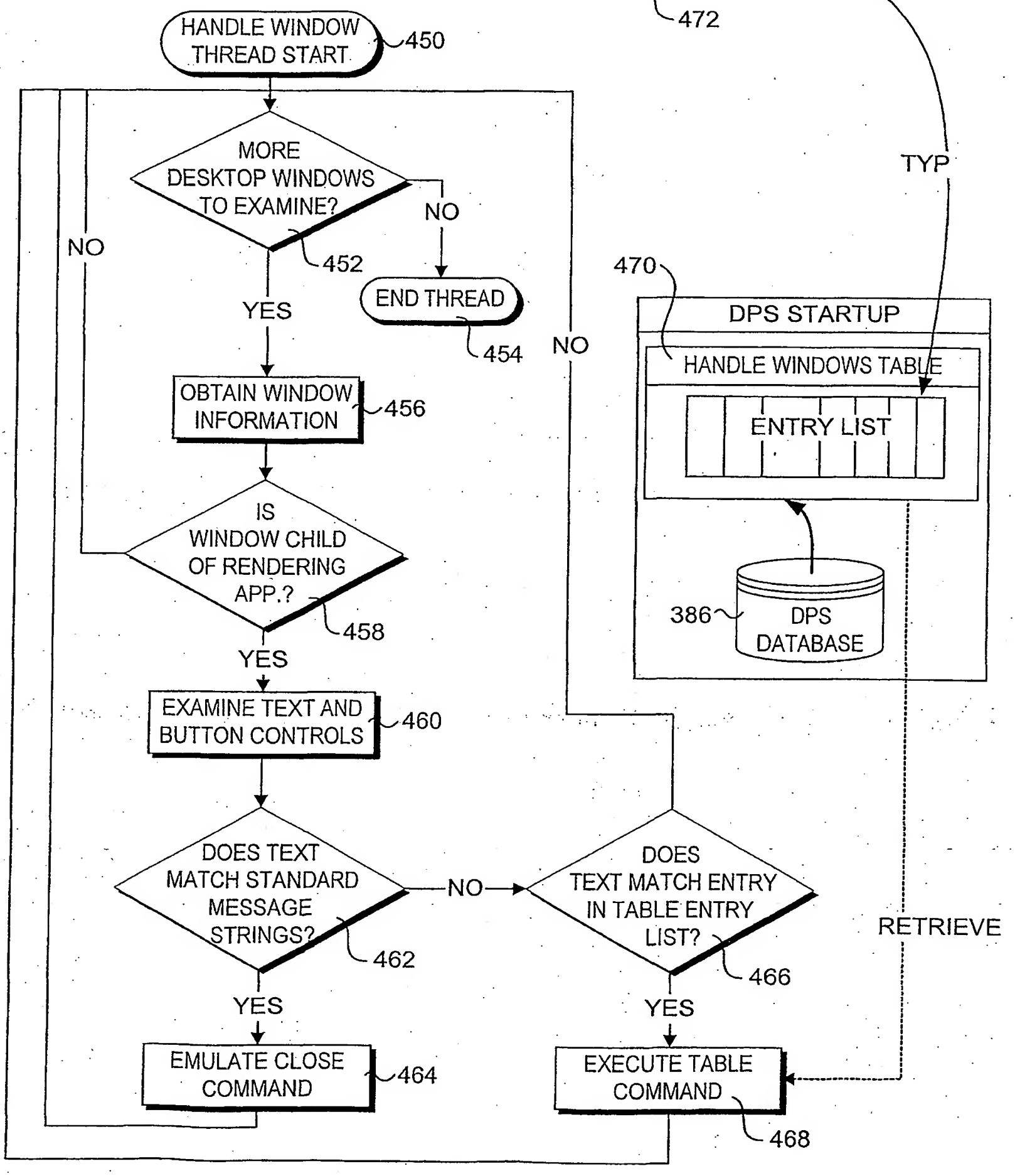


FIG. 19

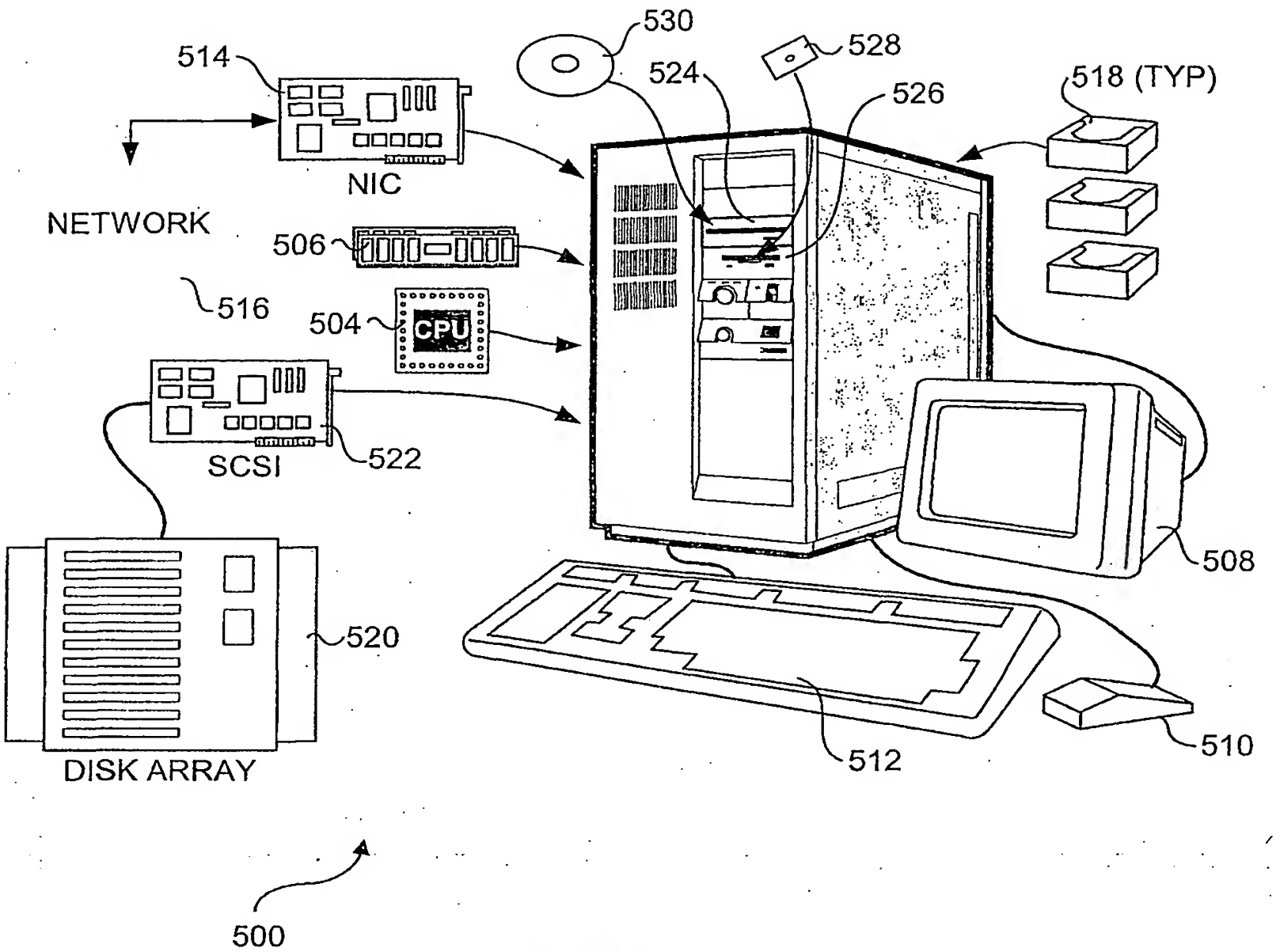

530
528
514
524
526
518 (TYP)
NIC
NETWORK
506
516
504
CPU
SCSI
522
508
520
512
510
DISK ARRAY
500

FIG. 20